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# ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

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Volume 82 — NEW YORK, THURSDAY, APRIL 17, 1919 — Number 16

## Modern Methods Applied To Group House Building

BUILDING a dwelling or a series of dwellings was raised during the war from a mechanic's job to an engineering operation. The designs for the numerous towns for the war workers involved little that was new. But the construction, turned over to contractors accustomed to handling large projects, was rushed through with methods and economies unknown in house building heretofore. Some of these methods are well illustrated in the article on another page describing the Cradock development. The effectiveness of machinery in place of men for such work cannot be questioned, although relative cost figures are not here available. Particularly to be noted for use where small amounts of concrete have to be placed over a large area is the system of central concrete mixing with distribution in tractor-drawn carts.

## Governmental Buying of Construction Material

CLAUSES in contracts providing for the purchase and delivery to highway contractors of all materials, thus relieving them of the hazard of price changes, have had many advocates in the past, particularly during the war. Such a plan, operated in Outagamie County, Wisconsin, was described in *Engineering News-Record* of Feb. 6, 1919, p. 289. The advantages of this procedure to the contractor are obvious. Besides the relief from the risks already referred to, there is released for use that part of the contractors' capital usually tied up in delivered materials. Responsibility for quality also rests with those who let the contracts, and, where large amounts of work are under way, the authorities, by controlling shipments and changing routings on the indications of daily reports, can deliver the right amount of material at all times, thus eliminating delays and demurrage charges. The advantages to the state or county may not be so apparent, but the adoption of the custom would no doubt reduce the cost of the finished road. An added incentive at the present time lies in the fact that lower freight rates are offered by the Railroad Administration on materials bought by Federal, state county, municipal and township governments. Considering these conditions, it would appear that now is a good time to try the system of Governmental buying.

## Engineering Council and the Nonmember Societies

WHAT relations should the Engineering Council have with the national, state and local engineering societies which are not represented in it? It is announced that the delegates from engineering societies who have been invited by the council to meet in Chicago April 23-25 to confer on plans for a Federal Department of Public Works will, on the third day of the conference, have an opportunity to discuss the above question. At present the council has 25 members, representing the national societies of civil, mining, mechanical, electrical and testing engineers. The combined membership of these five societies is about 40,000, or an everage of 1600 members per representative. It will be necessary to take into consideration these facts, in discussing any plans for direct representation of the smaller societies on the council. What is needed is confidence on the part of engineers that the council is endeavoring to act for the interest of the engineering profession as a whole and not merely for the more successful and conservative portion of the profession which is active in the national societies. Unless the council is sympathetic with all classes of the profession and all sections of the country, its mission is bound to be relatively narrow. Such recent acts of the council as the broad invitation to all engineering societies to join in the movement for a public-works department, and this frank request for practical suggestions as to how the council may coöperate with all engineering organizations, will in themselves help to increase the needed confidence.

## Navigation Improvement Under the Ohio Conservancy Law

A NEW application of the Ohio conservancy law, proposed by the city and county authorities of Cleveland, is under court test. Straightening of the Cuyahoga River where it winds along the bottom of its valley through the city is urgently necessary for the general commercial benefit of the city; it will improve navigation and thereby make dock property more accessible, will give far better utilization of the bottom lands for commercial purposes, will simplify railroad and freight distribution problems, will facilitate bridge and viaduct construction across river and valley, and, incidentally, will do something in the way of reducing the liability of floods in the bottoms. This is a new field of service for the conservancy law, which was drafted in the interests of flood protection as needed on the Miami and Scioto Rivers. However, the wording of the law specifically makes it applicable to broader purposes, and unless unforeseen objections are encountered the court may well find in its favor and decree the organization of a district. The fact is that river straightening at Cleveland is beset by many difficulties from the administrative viewpoint, and assessment of the costs upon the property directly benefited seems the only logical way to deal with the work on a justifiable basis of expenditure. There are unquestionably, many and sound objections to the creation of local improvement districts of this

character. Administered under the Ohio law, they are controlled without proportionate representation of the population assessed for the improvement. Objections of this character are sure to receive proper consideration in the court hearing, and the decision, by showing whether they prevail over the advantages obtainable in the Cleveland case, will represent a measurable advance in the processes of handling large public enterprises along rivers.

### One Township Employs Effective Road Publicity

TOWNSHIP highway work is often not appreciated for lack of proper publicity. If the officials make reports they are pigeonholed and forgotten unless brought out only as a matter of political expediency. It is all the more refreshing, therefore, to receive the eight-page report of the highway commissioner, H. H. Sherer, of New Trier township, just north of Chicago. Everything is noted, from the formation of an advisory board (made up of two lawyers, two architects, a banker, an engineer and a drainage expert) to the daily cost sheet of road-drainage work. The report shows what the budget taught, what was the necessity of developing a nearby gravel pit for repair work in place of the ordinarily used but more expensive crushed stone, how the road drag at $7.50 per day replaced a grader at $15 and was found to be the tool really needed because of excessive crowning, how a patrol system was established, and how the prospective ditch work uncovered the fact that surveys and dedicatory plats for many of the traveled roads did not exist. A map showing all the roads and drainage work done is included in the report, which was printed and sent to every citizen. Only $18,348 was spent, but if every township would make as good an account of its expenditures, there would be less criticism because of the millions wasted by local authorities.

### Narrow-Gage Railways Proposed in England

NARROW-GAGE railways in this country are relics of the past, but in England the exigencies of war and reconstruction are forcing them into engineering notice. Improved transportation is held there to be one of the immediate necessities. Strange as it may seem to an American, there are still many productive areas in England, isolated from the centers of consumption, which must be tied into the transportation net of the country if immediately increased production is to be realized. In France, and ready to go to France, when the war ended, was material for hundreds of miles of the light railways which had been developed so effectively in the zone of communications. These, it is urged, can now be put down in the remote districts of England by the experts who built similar ones in France, without the complicated legal and parliamentary procedure required to put through a standard-gage line and at much lower first cost and operating expense than either main-line railways or highways. The recrudescence of the almost forgotten narrow-gage will be watched with all the more interest now, on account of the growing claims of the highway and motor truck as a freight feeder. In this country the tendency has clearly been toward a larger and more effective use of highway transportation. Its recommendation is the very great flexibility of its vehicle—the motor car or the motor truck—and that advantage will be the great one against which the narrow-gage will have to contend if it is to receive attention.

### Making Geological Survey Maps More Popular

STUDIES looking to the popularization of Geological Survey maps are being made by the cartographers of the survey in order that persons who are unable to read contour maps may find at least some of the future sheets issued by this bureau of service to them. It has been found that by shading contour maps the topography can be shown so clearly that even bright boys are able to read them readily. The studies now in progress are for the purpose of determining the best method of shading. The use of hachures involves so much time and requires so much highly skilled drafting and engraving to produce really satisfactory results that it is not available for such work. Attention is, therefore, being focused on tinting as a means of portraying the relief, and some very encouraging results have been obtained. The relative elevations of flat surfaces are indicated by flat tints, darkest for the lowest plains, while the hills and mountains are shaded in accordance with the shadows which would exist when the light comes from a direction somewhat north of west. The time spent in surveying a region like the Yellowstone or Yosemite Park and preparing the standard contour maps from the results of these surveys is considerable, and if a little more time spent in tinting the maps will make them useful to the general public, which demands large numbers of maps of our scenic districts, a useful public service will be rendered.

### A Gasoline Tax On Motor Vehicles

HIGHWAY engineers are repeatedly raising the question as to the method by which motor trucks shall be made to pay a just share of the cost of building and maintaining highways. Comparison is often made with the economics of railway transportation, in which the shipper bears not merely the cost of operating the moving equipment but also a proper share of the cost of constructing and maintaining the track. In various states an attempt is made, by a graduation of motor fees, to charge back to the motor-truck user a proper proportion of the wear that the transportation of his goods causes to the pavement. Necessarily, these fees cannot be directly proportional to the use made of the road. Of two trucks of the same weight and capacity, paying the same yearly motor-vehicle tax, one may average only five miles a day and the other 30, the latter obviously causing six times as much wear on the highway as the less-used truck. To secure an equitable method of charging, it has been proposed to levy a tax on the gasoline consumed by motor vehicles. While there is some variation in fuel consumption between different makes of vehicles having the same carrying capacity, it is in general true that the fuel consumption is in direct proportion to the load and speed. At least, it is a closer measure of highway wear than anything we have found to date. Obviously, objections can be found to any form of tax. One of the apparent weaknesses of the gasoline tax is that a given capacity of vehicle carrying a certain load will produce more serious damage with hard-rubber tires than with pneumatic tires, and, again, still more serious damage if steel tires are

used. This difficulty for the present is a relatively negligible factor. In other words, practically all of the motor-truck traffic today is carried upon solid-rubber tires. If, in the future, the pneumatic tire becomes the standard for motor trucks of large capacity, some modification of the tax may be necessary, but, all things considered, the gasoline tax has much to commend it.

## Danger Ahead for American Society for Testing Materials

IN THE establishment of a new organization to deal with shape and quality standards of constructional materials, discussed in these columns last week, the American Society for Testing Materials has an intensely personal interest. For other societies, as the Civil Engineers, the Engineering Standards Committee movement is only a minor incident. For the American Society for Testing Materials it is a life-and-death matter.

No development in technical society life during the past twenty years is more noteworthy than the rise and fruitful service of the American Society for Testing Materials. Steadily and in purposeful manner it has worked for efficiency, improved quality and economy in the production of engineering materials, through the study of tests and the drafting of standard acceptance specifications. Its future has seemed as bright as its past. The society's vitality was rooted in its serious purpose, its independence, and the authority which it acquired by virtue of the strong working spirit and conscientious coöperation of its members. When it becomes a secondary organization, subordinate in both initiative and achievement, as it must under the working plans of the Engineering Standards Committee, the wellsprings of this vitality would inevitably be dried. The society could no longer hope to be a center of such spontaneous energy and enthusiasm as its members have hitherto brought to its work.

To the members of the society as well as to that large circle of technical and industrial men outside the society who have been aided by its work, the situation now existing is, we believe, of immediate and most urgent concern. The profound loss which would be suffered through paralysis and decay of the society can hardly be made up or overbalanced by gains through the activities of the Engineering Standards Committee. Members of the society, and especially participants in its committee work, will never believe that the society's methods can successfully be duplicated by a far-away mechanism of nontechnical direction, such as is now to be set into action.

The governing body of the society has participated in the Engineering Standards Committee movement from the outset, and the society is at present represented upon that committee. Doubtless those who direct the society's policy have believed that its position of supremacy in the field of quality specifications would not be harmed by a coöperative agreement with other societies. But can supremacy and subordination be brought into harmony? Can the society's position of unquestioned authority in the field of materials, won through the most sincere and conscientious labors, be retained if that final authority is yielded up to another body? We believe that it can be neither retained nor transferred, but will be lost.

It is a noteworthy fact that the man who more than others had inspired the spirit and created the methods of the society, the late Prof. Edgar Marburg, was very apprehensive of the influence of the Engineering Standards Committee movement upon the society, and opposed the plan of participating. No man knew better than he the difficulties inherent in intersociety coöperation, commonly called joint-committee work; no one had been more successful in directing such work, and no one better knew that technical as well as personal disagreements are bound to enter, regardless of the source. He did not fear the success of the Engineering Standards Committee, we feel sure; what he feared was its failure. He was of generous nature, and perhaps he would not have opposed the formation of a body that could do the work of the society if it would do it better. But he was too clearseeing a man and too strong a leader to look with favor on a plan that might submerge his own society without assuring that its work would continue.

Now that the committee is in a period of reorganization, new opportunity is afforded to consider the broad questions at issue. We urge upon the council of the American Society for Testing Materials that it review its prior decision to participate in the Engineering Standards movement; and we repeat that the matter is one of vigor or paralysis, of life or death, to the society and to the cause which it represents.

## Distributed Versus Centralized Passenger Terminals

WITH the growth of our cities the question of passenger terminals is one of repeated occurrence. The long drawn out discussions at Chicago and Cleveland are but the counterpart of what is being heard in dozens of cities in different parts of the country. The problems there may not be as acute, but as the number of cities of very large population increases there are sure to arise elsewhere situations just as difficult and provocative of as much discussion.

Usually, the discussion comes down to a dispute between the railroad and the representatives of the public. The railroad company faces large expense in the building of elaborate terminals in congested cities, while the public, seeking merely its own convenience, desires to dictate the location, and sometimes the character, of the terminal.

In all cases the argument revolves about the possibility of building another huge terminal, and the advantages and possibilities of the "distributed" type never come up for consideration. By "distributed" type is meant a shuttle service running into the congested sections from a terminal placed well outside of the city, such a shuttle road to have in town a number of stations similar to those of elevated and subway lines. It proposes, instead of a huge terminal putting on the railroads the terrific overhead of high property costs and an elaborate building, the substitution of a system relatively inexpensive and tending to give the people of the city a service far excelling the possibilities of the centralized terminal.

"Arrant nonsense," will be the immediate comment of many whose thoughts have never strayed beyond the huge terminal idea. But is it arrant nonsense?

Consider, for example, the Manhattan Transfer scheme of the Pennsylvania R.R. at New York. One can go from lower New York, from any Hudson and Manhattan tunnel station on Sixth Ave., from Hoboken, from Newark, from Harrison, from four points in Jersey

City, to Manhattan Transfer, and there wait for and board his train. The passenger need never see the Pennsylvania Terminal in New York City; he buys his ticket in any one of half a dozen places and checks his baggage at the same time. The passenger entering New York City, on the other hand, can terminate his journey at that one of the fifteen Hudson and Manhattan stations in the metropolitan district which best suits his convenience.

Moreover, the ferry systems of the various railroads terminating on the west bank of the Hudson River, opposite New York City, furnish another example of the distributed type of terminal. Land on the west bank of the Hudson is relatively expensive, yet not so expensive as that upon Manhattan Island itself. From each of these terminals radiates a number of ferry lines, dropping the passengers at points most convenient for them. Looking about, we can find other instances where the distributed terminal idea has been used to a minor extent. In Cleveland, Pittsburgh and Chicago there are stations in the outlying sections where goodly numbers of passengers board and leave through trains, while at Chicago the Elgin, Aurora & Chicago R.R., instead of having a downtown terminal, uses the Metropolitan Elevated Railroad Co.'s line and thus is able to distribute its passengers at any point on that extensive system.

Objections can be raised as the various difficulties involved in the distributed type are considered. What about waiting rooms, baggage, boarding trains which leave late at night, etc.? The answers to most of the objections can be found by a study of the Manhattan Transfer scheme of the Pennsylvania—although, manifestly, there, with a central terminal in addition to the distributed system, the full development of a distributed system has not been attained.

A distributed scheme may sound like "arrant nonsense" to those who blindly wrap themselves in tradition, but, from the standpoints of convenience and good business policy, it must give pause to those who defend as an alternative the $50,000,000 (and more) terminal, inconvenient because of its immensity, burdensome to the railroad as an investment, albeit monumental and creditable to a city which bears none of the cost, save to relieve later the inevitable street and transit congestion.

## Some New Ideas in Concrete Proportioning

PROPORTIONING concrete by volume is so firmly established that to many the method of designing a concrete mixture proposed by Professor Abrams, as outlined in an article on another page, may seem unduly complicated. It is true that the machinery of the method requires some rather involved explaining, but the method itself is simple enough and the theory back of it rational. That theory is that concrete strength and wear depend on optimum plasticity, which may be brought about by varying the three ingredients—cement, aggregate and water. The studies on which the method is based emphasize, first, the importance of water, and, second, the effect of the grading of the aggregate on the amount of either water or cement. Since cement is the more expensive of the two, the design of a concrete mixture resolves itself into the determination for any given aggregate of the proper amount of water with the minimum amount of cement. This is good economy, because on any job the aggregate is the variable, to which the cement and water can most readily be adjusted for the best possible concrete.

In particularizing the water-content problem in concrete, Professor Abrams has done a service to all concrete users. The subject is not new. The dry concrete of the late '90s was based on sound enough theory, which was forgotten or discarded in the rapid growth in the use of reinforced concrete, with its impeding steel. Four or five years ago the wet pendulum began swinging too far, and students of concrete commenced to sound the dangers of the overwet mix. Professor Abrams more than any other investigator has pinned impressions down with facts. Very definitely he has shown the quantitative as well as the qualitative rôle of water in concrete.

In his theory of aggregate grading he, too, is treading on familiar ground, only he has gone further than previous investigators. In place of the Fuller grading curve, which was supposed to give an aggregate of maximum strength-making properties, he substitutes an area which any number of curves may satisfy, and—what is crucial—indicates that any such area of sieve-grading curves has its own water or cement content to produce a concrete of given strength. This has wide application, because aggregate rarely occurs according to any required analysis.

It is evident, however, that the insistence on a proper water content is the most important feature of Professor Abrams' work. One may disagree with his fineness modulus theory or ask for more confirmation thereof, and still accept the principle of the optimum water-cement ratio. There is plenty of evidence that too much water is dangerous, but the trouble is that the rank and file of concrete workers do not yet appreciate it. The subject has been hammered and hammered for the past two years and needs more hammering. The general rule, "Use the smallest amount of mixing water that will produce a workable concrete," should be cast in bright letters on every concrete mixer in the country, and the men who tend that mixer taught what the words mean in the very concrete they are placing.

Engineers must translate into better concrete such work as the Lewis Institute laboratory is doing. They must disabuse the concrete workmen and foremen of their present idea that such studies as this one are what Professor Talbot at a recent convention referred to as "artists' stuff." They must emphasize and advertise the fact that concrete is not a casual composition but a delicately balanced mixture responsive to every variation in its content or method of manufacture.

And these same engineers should not forget that, highly scientific as is the designing theory advanced by Professor Abrams, at bottom its operation depends on practical experience and visual expertness. Throughout the discussion the importance of "workability" is emphasized. Just what is an optimum workability? On nearly every concrete job expert opinion differs. The added pint of water which takes away exactly so many pounds of compressive strength may make the difference between success and failure in getting the concrete out of the mixer. The extra plasticity which perfect design forbids may be necessary to insure complete covering of close-knit reinforcement. This by no means detracts from the desirability of so exact a design of the mix, but it does indicate—what, of course, is true of all engineering—that the finished engineer is the one who can apply to the elegance of the laboratory and of the study the solid experience of years of practical observation.

# Labor-Saving Machinery Used in Building Houses

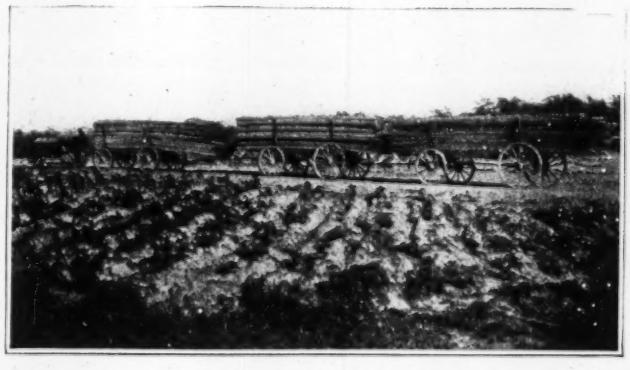
## Tractors Drag Plows and Also Haul Concrete Carts From Central Mixing Plant to All Parts of Extended Job—Lumber Pre-Sawed to Standard Sizes in Mill on Works

By Samuel H. Lea
Assistant Engineer, Cradock Housing Development, Portsmouth, Va.

CRAWLER TRACTORS HAUL MIXED CONCRETE AS FAR AS 1750 FEET ON UNITED STATES HOUSING DEVELOPMENT

LABOR was the element hardest to get in the construction of the United States housing project at Cradock, Va., which was started last summer, to provide homes for workers in the nearby Norfolk Navy Yard. For that reason a special effort was made to utilize all possible labor-saving devices and machinery, so that the men who could be obtained would be employed most effectively. This application of machinery extended from the unloading of material to the digging of the service trenches, but its most novel manifestation was the extensive use of the small tractor of the track-laying or "crawler" type to haul concrete from the central concreting plant and to do all manner of odd jobs of haulage around the works.

The original plans at Cradock contemplated sufficient houses for 5000 persons. After the armistice was signed it was decided to build 662 houses, including seven apartment buildings and 93 portable houses. All of these houses, together with the streets, roads, pavements and public-service appurtenances, had to be built on virgin ground on a site of about 400 acres adjacent to the Virginian R.R. and the Portsmouth-Gilmerton trolley line. In addition to the permanent housing buildings, there were many temporary buildings, such as bungalows and mess halls for the administrative force, barracks, kitchens, mess halls and canteens for the laborers, sawmills, storage buildings and hospitals.



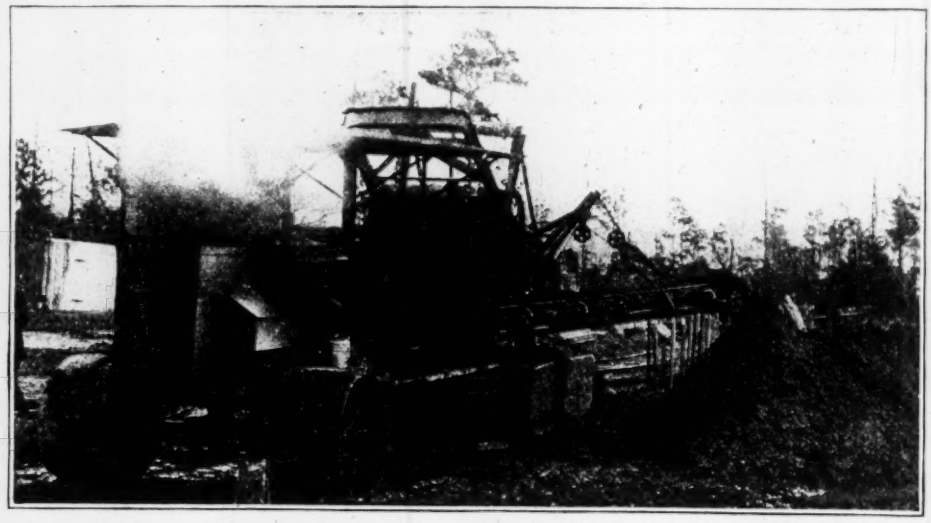
THREE TRAILER LOADS OF LUMBER BEING HAULED BY A SMALL TRACTOR

Convenience of transportation in the site was facilitated by the location of the main-line railway. A loop track from the Virginian R.R. extends through the project for 2.6 miles, including sidings and spurs. Material brought in could be run around this loop and discharged at convenient places, from which it was delivered to the job by trucks, tractors and horse-drawn wagons. Temporary roads were built to take care of this traffic, and preliminary surfacing was also placed on the permanent roads. About 4000 cu.yd. of road metal, comprising slag and stream and pit-run gravel, was used for surfacing the main thoroughfares through the project. Most of the temporary roads, made at an early period upon the natural surface, were of gravel or slag, forming a solid bed during the rainy period. They were located outside of the regular roadway, to be out of the way of grading operations, sewers and water lines.

On streets where the utilities had been installed and where settlement of the trenches was anticipated, the roadways were graded to subgrade, and the permanent paving was delayed. Where concrete pavement is to be constructed the roadway was excavated to a depth of 6 in. below subgrade. A layer of furnace slag was placed in the excavation and rolled until the surface was even with the subgrade. This temporary pavement is used for traffic and serves as a sub-base for the later concrete pavement.

One of the first applications of labor-saving methods was in the unloading of the lumber. Freight cars loaded with lumber were switched on a spur track, and

collapsible platforms were erected, one against either side of the car door. These platforms were made of 2 x 4-in. lumber about the width of a lumber truck, with the floor a few inches higher than the truck floor. A truckload of lumber unloaded from the car to each platform projected about 3 ft. beyond the end of the platform. The lumber truck had flat floors with rollers of 3-in. iron pipe extending across the floor at intervals of about 3 ft. These rollers were embedded so as to leave their tops about 1 in. above the floor. In loading, the truck was backed under the projecting end of the pile of lumber which covered the nearest floor roller; the truck was moved back until the lumber was fully loaded; the platform collapsed during the operation and fell to the ground, to be rebuilt for the next load, leaving the lumber load on the track. The side of the car held the lumber in place while the truck was backing under. When the truck loaded with lumber reached its destination, it was stopped at the required place, and was then started suddenly and moved forward a few feet, which caused the load to shift backward a short distance. The operation was repeated a few times and the truck was out from under the load ready for another trip.



TRENCHING MACHINE AT CRADOCK DEVELOPMENT AT WORK DIGGING SEWERS

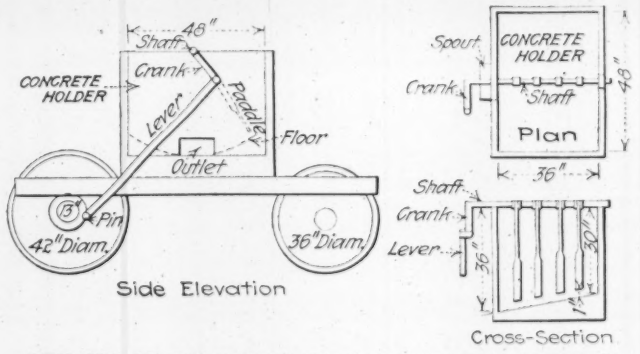
In getting the material around the job, the tractors which are seen in the views were useful. One view shows trucks with three loads of lumber. Such a train would make an average speed of six miles an hour along the temporary roads at the project. The same tractors were used for moving freight cars along the railroad track during the early part of the work before a locomotive was available. A log chain 10 or 12 ft. long was used for coupling the car to the tractor, which traveled close beside the track. One loaded freight car or two empties constituted a load. In one case a 10 x 12-ft. shack mounted on 6 x 8-in. skids was carried several hundred yards by three tractors traveling tandem.

The same tractors were used in clearing up the project before the construction started. They pulled down and removed small trees and stumps and, as shown in one of the views, were used to drag plows. Trees up to 3 in. in diameter were first cut around the roots, and a log chain was attached to the trunk several feet from the ground. The other end of the chain was hooked to a tractor which pulled down the tree and dragged it away. In plowing, the tractor was attached to the plow by a long chain.

Pre-sawed material was used in all the buildings, which were of frame throughout. The sawmill was equipped with swing saws which could be turned to any required angle for making square or mitered cuts of framing lumber and for the interior and exterior trim of the buildings.

From four to six pieces would be sawed at the same time. Pieces of lumber ready for use were passed from the saws through the mill door onto the truck or trailer. Each machine saw was driven by an independent electric motor. The mill supplied material for framing and for trim for from 10 to 15 houses per day.

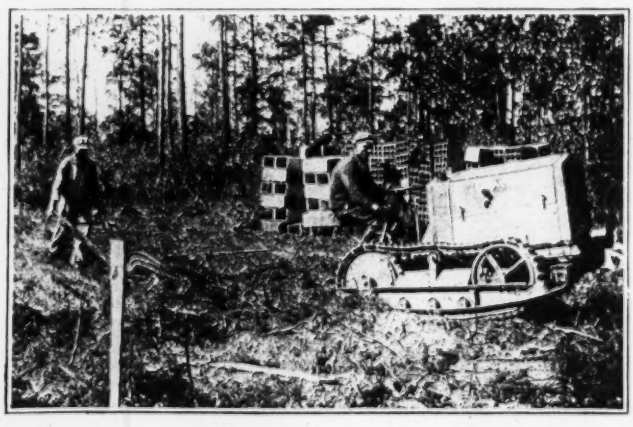
Concrete for the foundations of the buildings and for such other uses as were required was made at a central mixing plant and hauled to the place in special carts by



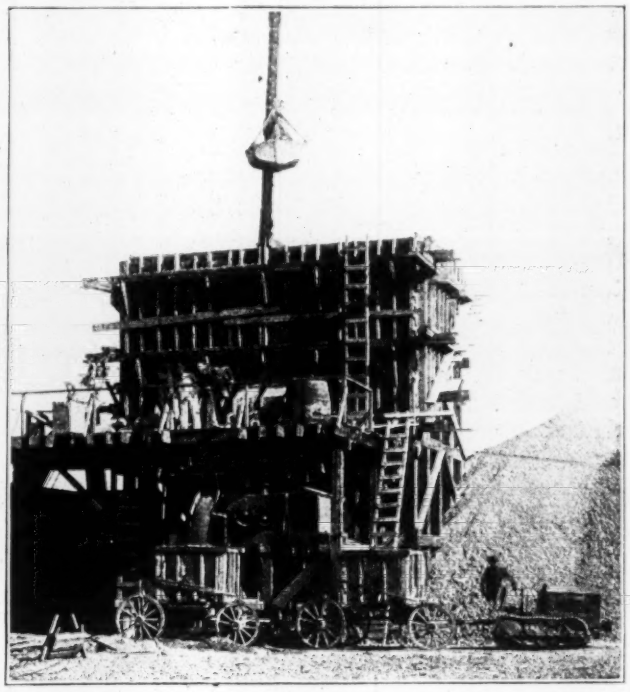

DETAILS OF CART IN WHICH CONCRETE IS CARRIED TO WORK

the same tractors. These carts, a drawing of which is seen above, have interior paddles which agitate the concrete during transportation and keep it in shape for use when delivered. The mixer, which is electrically driven, is upon an elevated platform, the concrete being discharged by gravity into the wagon.

The aggregates are taken from open-top freight cars

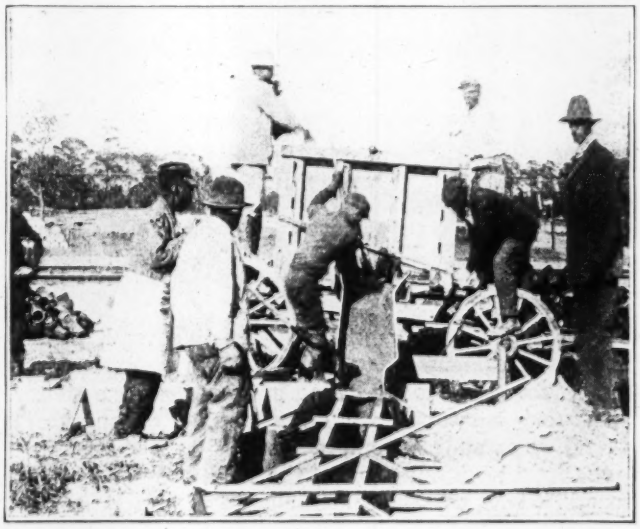


PLOWING FOR A HOUSING DEVELOPMENT WITH A TRACTOR FOR A MULE



TRACTOR-DRAWN CONCRETE CARTS BEING FILLED AT CENTRAL MIXING STATION

in a clamshell bucket operated by a steam derrick, and are deposited in bins above the mixer or in nearby stockpiles. Cement is carried from the adjacent storage room to the mixer platform by an electrically operated endless chain elevator. The loaded concrete wagons are hauled one or two at a time to place by the tractors, and the concrete is deposited through a small chute, shown in one of the views. The concrete is kept stirring during the trip by the agitator, which is operated by



DISCHARGING CONCRETE FROM A WAGON INTO HOUSE FOOTING THROUGH A CHUTE

a lever attached to one of the rear wheels of the wagon. A 1½-in. round iron shaft across the wagon top is mounted on trunnions near the end. Four iron paddles, ⅞ x 2 in., are attached to the shaft and extend vertically to within about 1 in. of the sloping wagon bottom. The shaft is connected to a collar on the outer end of the hub. As the wagon moves the wheel revolves and operates the lever, which moves the four iron paddles back and forth through the concrete. On the long runs a distance of 1750 ft. was traveled, making a total of 3500 ft. for the round trip, which required 10 minutes. This included time taken for loading and placing the concrete after mixing.

Trenches for sewers and water mains were dug both by hand and machine. The deeper trenches were mostly excavated by hand, because the sides would cave so quickly behind the machine that the sheeting could not be placed and secured. This rapid caving was caused by the vibration of the heavy machine on the soft ground. At depths of from 4 to 7 ft., however, the machine was successfully operated, and a good-sized gang was kept busy laying pipe behind it.

Roadway grading was done with an elevating grader drawn by 16 horses. The excavated material is loaded into bottom dumping wagons and hauled to low places for filling. Only short runs can be made without turning, so conditions were not particularly favorable for this method of grading.

The average day's work is 225 cu.yd. of earth in cuts from 4 to 12 in. in depth, and the cost is about $1 per cubic yard of earth removed.

The Cradock development was in charge of the United States Housing Corporation. George B. Post & Sons, of New York, prepared the general architectural plans

ELEVATING GRADER PULLED BY SIXTEEN HORSES MAKING NEW STREETS

for the project. Hill & Ferguson, of New York, were the supervising engineers until Jan. 1, 1919, when G. C. & A. E. Wheeler, of New York, took over that end of the work. The Hegeman-Harris Co., Inc., of New York, is the general contractor; and William Wooley is works superintendent.

## Water Treatment Saves Lives and Money

Reduction in the annual typhoid death rate of 54 per 100,000 at Columbus, Ohio, due to the introduction of a purified water-supply, means a financial saving of $1,188,000 for 2.2 years. This estimate was given by Prof. C. W. Fould, of Ohio State University, in a paper read before the Engineers' Club of Columbus, and was based on Mr. Whipple's estimate of $10,000 loss to a community for each death by typhoid. A total yearly saving per household (five persons) is made up of $3 saving on soap, $17 on plumbing and $15 in doctor's bills, funeral expenses and loss of time. Thus, for each household there is an average annual saving of $35 due to the purifying and softening of the city water.

# Engineering Civic Federation

## Proposed Organization of Engineering Societies Based Upon Our Political System of Representation

By W. L. Saunders
Past President, American Institute of Mining Engineers

THE engineers' symposium held in the auditorium of the Engineering Societies' Building in New York City, Mar. 26, 1919, brings prominently before us the question whether or not citizens of the United States, engaged in engineering and other scientific pursuits, are willing to organize for the purpose of using the influence of technical men in civic affairs. The speeches and the discussions showed clearly that there is something wrong with the present situation, that a great opportunity now exists for the engineer to render real service to the community.

Dr. Ricketts, in an address to the Engineering Association of the Princeton Club, said: "We vote, but we do not really serve our community, state and county. We have been so absorbed in advancing the industries with which we have been connected that we have failed to exercise our proper influence in behalf of the community. We have established splendid engineering schools where graduates are given superior technical training, but are not inspired by the true spirit of service to the commonwealth."

In order to crystallize this subject into a practical plan, it would seem that the first thing to do is to get together on fundamentals. There is much confusion and some difference of opinion as to whether this movement should be one of coöperation among engineering societies or whether it should take the line of an independent organization of engineers and scientific men, federating citizens of technical thought and training into a broad, nation-wide organization, planned in accordance with American ideals and to meet the conditions that exist in a democratic form of government.

### Objects of Associations

Engineering associations, national and local, are usually organized and directed for the purpose of advancing engineering knowledge and for the maintenance of high professional standards. Such organizations are of the greatest value and importance to the profession, but their very nature tends toward concentration upon purely technical lines and to separation from civic and social duties. The highly trained civil engineer naturally considers that he is a better judge of things involving civil engineering than is any other type of engineer. He also considers his judgment superior to that of one of his juniors. If a question is before a legislative body, involving civil engineering, he would not look favorably upon a proposition to consider his vote as only equal to that of other men in the profession. He would naturally, and reasonably, favor submitting the question to a body of civil engineers.

The conclusion from this premise leads to permitting the engineering societies to take separate action in public questions. The unfortunate part of this, however, is that it is neither wise nor effective. It does not conform to the American system of government. Such a system is fundamentally one where the man in the street has an equal vote with the man in the counting house, even on a banking question, and experience has shown over and over again that legislative bodies are not influenced by banking associations when banking questions are before them. This may not be right, but it is a fact. It was shown recently in the case of the Federal Reserve act, which was opposed by the bankers and which is now generally approved.

Let me illustrate this point in another way: Let us suppose a project to be before a county board, a state legislature, or any governing body, involving the construction of either a bridge across or a tunnel under a stream. The civil engineer would perhaps be more interested in a bridge, the mining engineer in a tunnel. The question might appeal to the governing body on lines of general public interest; matters of finance may come in, so that a decision rendered on broad grounds should have its influences reach out to lines of general technical and commercial knowledge.

An association of technical men without special predominance in any branch of engineering is not only likely to do more effective work, but its influence would be broader. There may be but a few civil engineers in

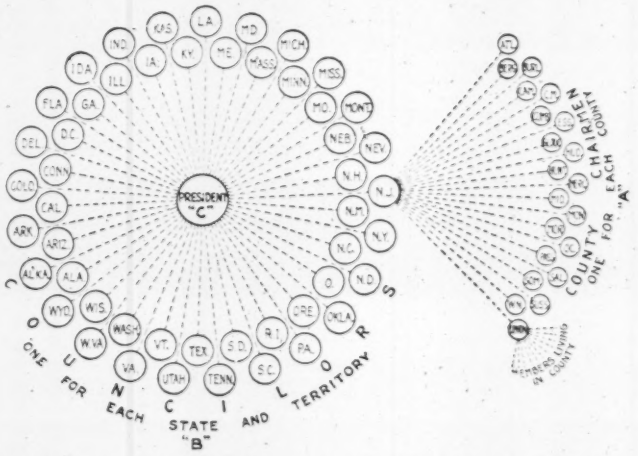

PRESIDENT "C"
COUNCILORS
ONE FOR EACH STATE AND TERRITORY "B"
COUNTY CHAIRMEN ONE FOR EACH COUNTY "A"
MEMBERS LIVING IN COUNTY

CHART OF PROPOSED SCHEME OF REPRESENTATION

A. *A County Chairman* for each county in each state and territory, elected by the majority vote of members who are legal voters in the county.

B. *A Councilor* for each state and territory, elected by the majority vote of the county chairmen in each state and territory.

C. *A President* elected for two years by the majority vote of the councilors.

*A Governing Council* to consist of the president and the councilors, who shall conduct all the affairs of the organization and who may vote by letter ballot.

Each county may express through a referendum in the county, the opinion of the county only on any question, but the opinion of the organization can only be expressed through a referendum vote of all the members of the Engineering Civic Federation.

that particular county or state, and this small group, acting in a community, would not be likely to have as much effect upon the governing body as the more widely distributed influence of a large number of engineers who might actually have been reasoned to their position by the superior intelligence of the small body of civil engineers. This would be specially so if the right and strength of the matter were on the side of this small group.

### Engineering Societies Not Effective

The first reason why engineering societies are not likely to be effective as such in public matters is that, *their chief function being technical, they are now engaged and should continue to devote their time and energies, from the president down, to the advancement of scientific knowledge, and that if they attempt to divert those energies to public questions they are likely to do less in this fundamental line, which in itself is*

*of the greatest importance.* Furthermore, a departure from their true province to one which borders on politics will threaten to disrupt the organization.

It is proposed to organize an Engineering Civic Federation on practically the same basis as that on which the Chamber of Commerce of the United States has been established to represent business. Business men have their manufacturers' associations, their bankers' clubs, their trade associations, reaching into many lines of activity. They federate under the national chamber, an organization which is geographically widely distributed, the membership of which comprises all lines of business from the head of a large corporation down to the corner grocer. When this national chamber speaks it is with the voice of business, uninfluenced by personal considerations. It is the popular expression of the American business world. Why not have such an expression from the engineering world? If we make the attempt let us make it on a broad and not a narrow scale. Let us follow American systems.

The proposed Engineering Civic Federation is based in principle upon the national political organizations of the country. All members living in any county of any state elect a county chairman. The several county chairmen in each state by majority vote elect a councilor; the several councilors by majority vote elect a president. There is complete autonomy in each county, in each state and in the nation. Subjects relating to county interest only should be considered by the county members only, questions of state interest by state members only, and national questions by the entire organization. The opinion of the organization on public questions should be expressed only through a referendum.

It is proposed to elect Gen. George W. Goethals president. He is retired from the Army and is now in civic life. Here we have a man of international reputation, a great executive, through whom a membership at $1 or $2 each per annum of from 75,000 to 100,000 technical men might be enlisted for service. The possibilities of such an organization can scarcely be overestimated. Annual meetings might be held in Washington, D. C.; state meetings more frequently in each state, and county members might get together at any time. There should be no jealousy excited among the various engineering and scientific societies by such an organization as this. *It does not encroach upon their province. On the contrary, it draws a clear line of distinction between maintaining high professional standards and federating technical men for public service.*

The engineer has no one but himself to blame because his influence is so much less than that of the lawyer. He has been too modest. He looks upon engineering as too serious a thing, he hides his light beneath a bushel, he is too fond of avoiding the mire of politics, giving too little consideration to the fact that politics enters into every part of our life, and that if there is a mire there it is because the men who are best fitted to clean it up do not go in. We have a part to play—now let us play it. The problems of civilization are daily becoming more and more technical. The United States is the greatest industrial nation of the world. It is the engineer who has built up this industry. The men who have built it up are best fitted to conduct it, for engineering today is the art of organizing and directing men and of unfolding and utilizing the works of nature for the benefit of the human race.

## Public Works Department Would Spend Over $125,000,000 Annually

THE accompanying table shows the annual disbursements for four years of some of the principal bureaus of the Federal Government which it is proposed to bring together under control of a Federal Department of Public Works. (See *Engineering News-Record* of Apr. 10, 1919, p. 722.) The figures for the expenditures for 1918 are not yet available, but an increase of great importance is the appropriation for

ANNUAL DISBURSEMENTS BY FEDERAL GOVERNMENT BUREAUS CHIEFLY ENGAGED IN ENGINEERING WORK

| | 1914 | 1915 | 1916 | 1917 |
|---|---|---|---|---|
| *Treasury Department* | | | | |
| Public Health Service | $2,264,676 | $2,767,820 | $2,839,017 | $3,045,598 |
| Supervising Architect | 15,969,970 | 19,953,643 | 16,621,567 | 17,878,023 |
| *War Department* | | | | |
| Public Buildings and Grounds | 427,097 | 404,166 | 408,801 | 411,189 |
| Rivers and Harbors | 49,921,592 | 46,833,914 | 32,450,301 | 30,487,599 |
| *Interior Department* | | | | |
| Geological Survey | 1,368,544 | 1,361,842 | 1,378,641 | 1,342,279 |
| Reclamation Service | 7,709,350 | 12,091,685 | 5,891,614 | 4,993,732 |
| Bureau of Mines | 660,509 | 710,307 | 681,681 | 815,156 |
| Alaskan Engineering Commission | | 2,000,000* | 8,647,620* | |
| *Department of Commerce* | | | | |
| Bureau of Standards | 595,469 | 634,303 | 790,169 | 784,693 |
| Bureau of Lighthouses | 5,731,075 | 5,607,966 | 5,722,146 | 5,861,511 |
| Coast and Geodetic Survey | 999,375 | 1,095,301 | 1,178,860 | 1,229,288 |
| *Department of Agriculture* | | | | |
| Bureau of Public Roads | 225,282 | 267,241 | 442,843 | 503,325 |
| Weather Bureau | 1,548,936 | 1,348,087 | 1,324,627 | 1,406,070 |
| Forest Service | 3,201,718 | 3,580,508 | 3,286,086 | 2,913,744 |
| *Panama Canal* | 34,826,941 | 9,187,042 | 17,503,728 | 19,262,798 |
| Totals | 125,450,534 | 125,843,825 | 99,167,701 | 90,935,60 |

* Appropriations.

Federal aid to state road construction, expended under direction of the Bureau of Public Roads. The appropriation for the coming year for this purpose is $100,000,000.

If the above rate were to continue, the total expenditures of the proposed Department of Public Works would probably be in the neighborhood of $250,000,000—a greater amount than was disbursed by any department of the Government prior to the war.

## Compression Tests Show Effect of Silt

Results of compression tests of portland cement mortars and concrete containing various percentages of silt, made by A. C. Alvarez and J. R. Shields, are published in a bulletin issued by the University of California, Berkeley, Cal.

In discussing the results of the recent tests, the authors offer explanations of the observed fact that in general the strength of all mortars decreased with increase in percentage of silt; but up to 10% of silt this decrease in strength averaged only about 4.5%; the decrease in strength jumped to an average of 15% for the addition of 14% of silt. The strength of 1 : 2 : 4 concrete increased when silt was added; the more so the greater the percentage of silt, 14% increasing the strength about 15%. The leaner the mixture, the greater is the percentage of silt which may be added with beneficial results.

It is concluded from the results of the tests that neither the injury to mortar nor the benefit to concrete due to the presence of 14% of silt is great. Such an amount of silt would be valuable to make mortar or concrete less permeable to water. The word silt refers to very fine, inert particles of durable minerals that have no chemical action on portland cement

# How to Design Concrete Mixtures

## Proper Proportions Can Be Determined for Different Kinds of Material—New Theories Regarding Aggregate Grading Advanced by D. A. Abrams as Result of Tests

PROPORTIONING concrete on an arbitrary volumetric ratio of the elements is a practice of long standing. Probably 90% of the concrete made today is specified to be a 1:2:4 mix, regardless of the material that makes the concrete. But for some years past a number of experimenters have been studying the make-up of concrete in the hope of discovering some more rational method of proportioning which will take into account the properties of the aggregate and the strength to be desired. Prominent among such investigators is Prof. Duff A. Abrams of the Structural Materials Research Laboratory of the Lewis Institute, Chicago. In the past three years this laboratory has made some 50,000 tests in the study of proper proportioning, as a result of which Professor Abrams has deduced a rational theory which permits the design of a concrete mixture from the particular aggregate available. His theories were advanced in a paper read before the Portland Cement Association in December, 1918, and have now been issued as Bulletin 1 of the Structural Materials Research Laboratory of the Lewis Institute. They are so important, however, that they are given in considerable detail in this article.

Experience has shown that the ordinary volumetric proportioning is far from satisfactory. The Chicago experiments further showed that other methods advanced are subject to serious limitations. They found, for instance, that the maximum strength of concrete does not depend on either an aggregate of maximum density or a concrete of maximum density, and that the methods which have been suggested for proportioning concrete by straight sieve analysis of aggregate are based on an erroneous theory. Furthermore, the tests emphasized what has been the growing impression in the past few years that proper attention has not been given to the water content of a concrete mixture. As noted in Professor Abrams' paper in *Engineering News-Record* of May 2, 1918, p. 873, the tests show that very small variations in water content produce more important variations in the strength and other properties of concrete and similar changes in other ingredients.

Fundamentally, the main principles of Professor Abrams' theory are as follows: (1) With given concrete materials and conditions of test, the quantity of mixing water used determines the strength of concrete so long as the mix is of a workable plasticity; (2) a measurement of aggregate grading on a sieve, giving rise to a function known as the "fineness modulus" of the aggregate, is of the greatest importance in proportioning a mixture.

As corollaries to these main principles, it is stated that the aggregate grading which produces the strongest concrete is not that giving the maximum density—that is, the lowest voids. A grading coarser than that giving maximum density is necessary for highest concrete strength. The shape of the particle and the quality of the aggregate have less influence on concrete strength than has been hitherto reported. There is an intimate relation between the grading of the aggregate and the quantity of water required to produce a workable concrete.

The effect of water on the mix was shown in the article in *Engineering News-Record* of May 2, 1918. Tests represented by the diagram in Fig. 1 demonstrate that so long as the mix is workable, compressive strength of the concrete is a function of the ratio of the volume of water to the volume of cement in the batch—that is, the formula $S = A/B^x$ is generally applicable, where $S$ is the compressive strength of the concrete, $x$ is the ratio of the volume of water to the volume of cement, and $A$ and $B$ are constants whose values depend on the quality of the cement used, the age of the concrete, curing conditions, etc. For the tests in question this formula becomes $S = 14{,}000/7^x$.

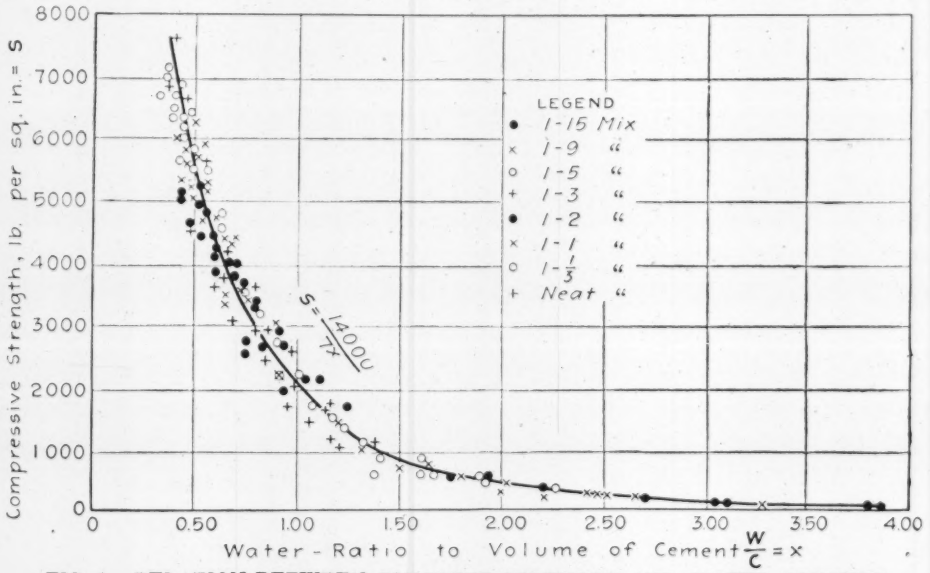



FIG. 1. RELATION BETWEEN CONCRETE STRENGTH AND WATER CONTENT
Twenty-eight-day compression tests on 6 x 12-inch cylinders.

The strength of the concrete responds to changes in water regardless of the reason for these changes. The water ratio may be changed, due to any of the following causes: (1) Change in mix (cement content); (2) change in size or grading of aggregate; (3) change in relative consistency; (4) any combination of 1 to 3. It should not be concluded that the tests indicate that lean mixtures can be substituted for richer ones without limit. The limitation is the necessity of using sufficient water to secure a workable mix. Therefore, according to Professor Abrams, the problem of designing concrete mixes resolves itself into the following: To produce a workable concrete which has a given water ratio, using a minimum quantity of cement, or the converse,

to produce a workable concrete with a minimum water ratio using a given quantity of cement. The method of securing the best grading of aggregate and the use of the driest concrete which is workable are thus seen to be only devices which enable the accomplishment of the above mentioned results.

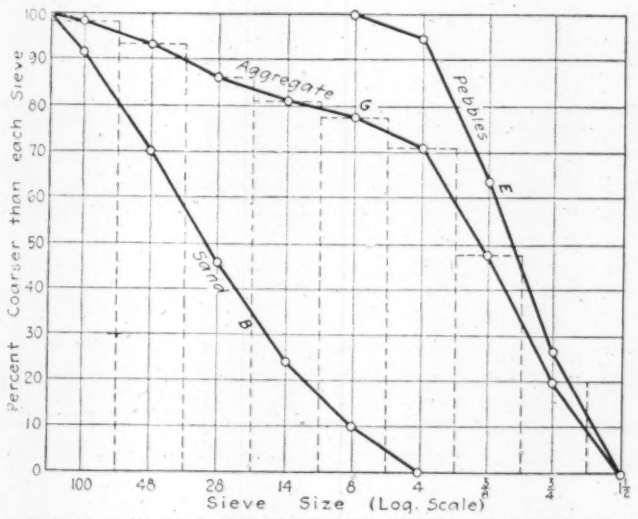



FIG. 2. METHOD OF PLOTTING SIEVE ANALYSIS OF AGGREGATES

Sieve analysis curves for aggregates B, E and G in Table I.

TABLE I. METHOD OF CALCULATING FINENESS MODULUS OF AGGREGATES

Sieves commonly known as the Tyler standard sieves; each sieve has a clear opening just double that of the preceding one.
The sieve analysis may be expressed in terms of volume or weight.
The fineness modulus of an aggregate is the sum of the percentages given by the sieve analysis, divided by 100.

| | | | Sieve Analysis of Aggregates Per Cent. of Sample Coarser Than a Given Sieve | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Size of Square Opening | | Sand | | | Pebbles | | | Concrete |
| Sieve Size | In. | Mm. | Fine (A) | Medium (B) | Coarse (C) | Fine (D) | Medium (E) | Coarse (F) | Aggregate (G)* |
| 100-mesh | 0.0058 | 0.147 | 82 | 91 | 97 | 100 | 100 | 100 | 98 |
| 48-mesh | 0.0116 | 0.295 | 52 | 70 | 81 | 100 | 100 | 100 | 92 |
| 28-mesh | 0.0232 | 0.59 | 20 | 46 | 63 | 100 | 100 | 100 | 86 |
| 14-mesh | 0.046 | 1.17 | 0 | 24 | 44 | 100 | 100 | 100 | 81 |
| 8-mesh | 0.093 | 2.36 | 0 | 10 | 25 | 100 | 100 | 100 | 78 |
| 4-mesh | 0.185 | 4.70 | 0 | 0 | 0 | 86 | 95 | 100 | 71 |
| ¾-in. | 0.37 | 9.4 | 0 | 0 | 0 | 51 | 66 | 86 | 49 |
| ¾-in. | 0.75 | 18.8 | 0 | 0 | 0 | 9 | 25 | 50 | 19 |
| 1½-in. | 1.5 | 38.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fineness Modulus | | | 1.54 | 2.41 | 3.10 | 6.46 | 6.86 | 7.36 | 5.74 |

* Concrete aggregate "G" is made up of 25% of sand "B" mixed with 75% of pebbles "E." Equivalent gradings would be secured by mixing 33% sand "B" with 67% coarse pebbles "F"; 28% "A" with 72% "F," etc. The proportion coarser than a given sieve is made up by the addition of these percentages of the corresponding size of the constituent materials.

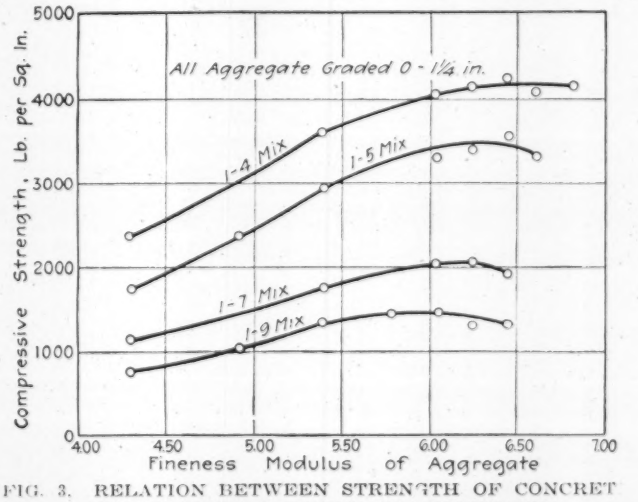



FIG. 3. RELATION BETWEEN STRENGTH OF CONCRETE AND FINENESS MODULUS OF AGGREGATE FOR DIFFERENT MIXES

In further investigation of the aggregate, the function called the "fineness modulus" was set up. In brief, this modulus is the sum of the percentages of the aggregate in a certain type of sieve analysis divided by 100. The sieve analysis is determined by using the following sieves from the Tyler standard series: 100, 48, 28, 14, 8, 4, ⅜-in., ¾-in., and 1½-in. These sieves are made of square-mesh wire cloth. Each sieve has a clear opening just double the width of the preceding one. The exact dimensions of the sieves and the method of determining the fineness modulus are found in Table I. It will be noted that the sieve analysis is expressed in terms of the percentages of the material by volume or weight *coarser* than each sieve. A well graded torpedo sand up to No. 4 sieve will give a fineness modulus of about 3; a coarse aggregate graded 4-1½ in. will give a fineness modulus of about 7; a mixture of the above materials in proper proportions for a 1:4 mix will have a fineness modulus of about 5.80. A fine sand such as drift sand may have a fineness modulus as low as 1.50.

In explaining the use of the fineness modulus, Professor Abrams continues as follows:

There is an intimate relation between the sieve analysis curve for the aggregate and the fineness modulus; in fact, the fineness modulus permits the proper interpretation of the sieve analysis of an aggregate. If the sieve analysis of an aggregate is platted in the manner indicated in Fig. 2, that is, using the per cent coarser than a given sieve as ordinate, and the sieve size (platted to logarithmic scale) as abscissa, the fineness modulus of the aggregate is measured by the area below the sieve analysis curve. The dotted rectangles for aggregate "G" show how this result is secured. Each elemental rectangle is the fineness modulus of the material of that particular size. The fineness modulus of the graded aggregate is then the summation of these elemental areas. Any other sieve analysis curve which will give the same total area corresponds to the same fineness modulus and will require the same quantity of water to produce a mix of the same plasticity and gives concrete of the same strength, so long as it is not too coarse for the quantity of cement used.

### Fineness Modulus Strength Relation for Concrete

Many separate series of tests have shown that for a given plastic condition of concrete and the same mix there is an intimate relation between the fineness modulus of the aggregate and the strength and other properties of the concrete. We have seen that the reason for this result is found in the fact that the fineness modulus simply reflects the changes in water-ratio necessary to produce a given plastic condition.

Figs. 3 and 4 give the results of certain compression tests which bring out the relation between the strength of the concrete and the fineness modulus of the aggregate. It

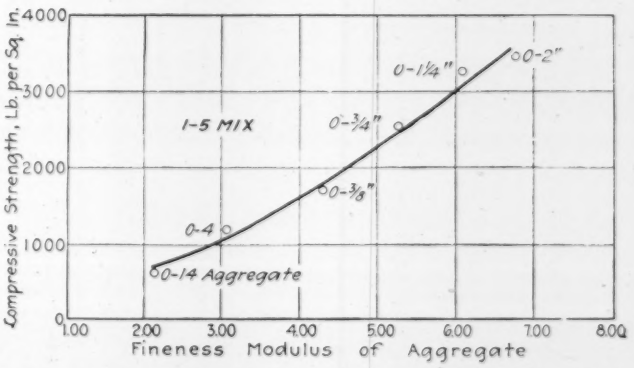



FIG. 4. RELATION BETWEEN STRENGTH OF CONCRETE AND FINENESS MODULUS FOR DIFFERENT SIZES

will be noted from Fig. 3 that a separate curve may be drawn for each mix. In each case there is a steady increase in the compressive strength of the concrete as the fineness modulus of the aggregate increases, until a certain value is reached which corresponds to a maximum point. It will be noted also that this maximum point corresponds to higher and higher values of fineness modulus as the quantity of cement in the mix is increased. In other words, the maximum strength comes at a fineness modulus of about 5.80 for the 1:9 mix and about 6.40 for the 1:4 mix. In these tests the different values of the fineness modulus were secured by using a preponderance of the coarser sizes, but in all cases maintaining the same limiting size, that is, 1¼ inches.

In Fig. 4 is found a similar relation between the strength and the fineness modulus, except that no maximum point is found. This condition arises from the fact that the maximum size of the aggregate is increasing without changing the type of the sieve analysis curve, consequently the fineness modulus strength curve continues to rise indefinitely. The height to which the curve rises is limited only by the maximum size of aggregate which may be used. It is important to note that there is no conflict between the indications of Figs. 3 and 4.

A given value for the fineness modulus of an aggregate can be secured with any combination of percentages in the sieve analysis which gives the same total; consequently, an infinite variety of gradings may be found which give aggregate of the same concrete strength. Table II gives the results of groups of tests which bring out the wide variation which may be made in the grading of aggregate without producing any essential variation in the concrete strength. Twenty-seven different gradings of the same aggregate were made up. These gradings covered the widest possible range, but they had one property in common; that is, a fineness modulus of 6.04. All specimens were mixed with the same quantity of cement and water. Separate sets of specimens were made of two different consistencies.

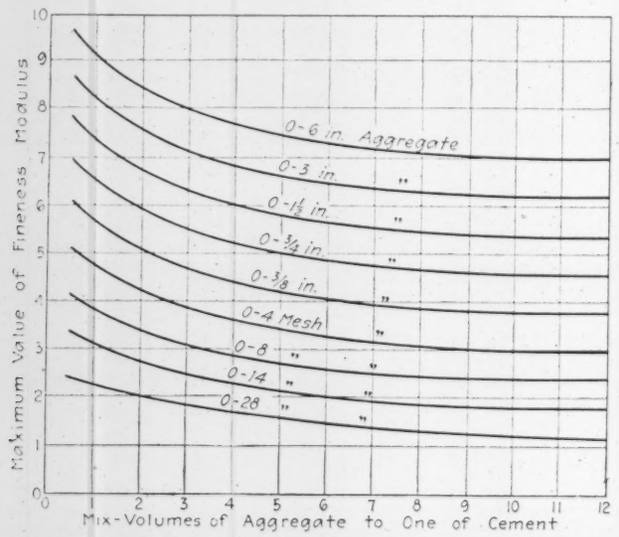



FIG. 5. MAXIMUM PERMISSIBLE VALUES OF FINENESS MODULUS OF AGGREGATE
Graphical representation of Table III. Based on sand and pebble aggregate.

TABLE II. EFFECT OF GRADING OF AGGREGATES ON THE STRENGTH OF CONCRETE

Compression tests of 6 by 12-in. concrete cylinders. Mix 1:5 by volume; age at test, 28 days; stored in damp sand; tested damp.
Aggregates—sand and pebbles from Elgin, Ill. Aggregates were screened to different sizes and recombined to conform to predetermined sieve analyses.
Same quantity of water was used in all specimens of a given consistency. The 110% consistency contains 10% more water than the 100%.
Each value in the strength tests the average from 5 tests made on different days

| Ref. No. | Sieve Analysis of Aggregate Per Cent. Coarser than Each Sieve: 100 | 48 | 28 | 14 | 8 | 4 | ⅜ | ¾ | 1¼ | 1½ | 2 | Fineness Modulus of Aggregate | Surface Area of Aggregate Sq.In. Per Lb. of Aggregate | Per G. of Cement | Compressive Strength of Concreteat 28 Days (Lb. per Sq.In. 100% Consistency | 110% Consistency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 99 | 98 | 95 | 90 | 81 | 68 | 49 | 24 | 0 | | | 6.04 | 602 | 8.8 | 3,300 | 2,890 |
| 259 | 99 | 98 | 96 | 92 | 84 | 67 | 46 | 22 | 0 | | | 6.04 | 569 | 8.2 | 2,950 | 2,650 |
| 260 | 98 | 97 | 93 | 88 | 80 | 67 | 52 | 29 | 0 | | | 6.04 | 764 | 11.4 | 3,120 | 2,760 |
| 261 | 97 | 94 | 91 | 85 | 77 | 67 | 58 | 35 | 0 | | | 6.04 | 999 | 15.2 | 3,140 | 2,790 |
| 262 | 95 | 92 | 87 | 82 | 75 | 67 | 67 | 39 | 0 | | | 6.04 | 1,292 | 20.1 | 3,100 | 2,800 |
| 263 | 95 | 90 | 84 | 78 | 73 | 67 | 62 | 55 | 0 | | | 6.04 | 1,451 | 23.0 | 2,830 | 2,740 |
| 264 | 95 | 89 | 82 | 75 | 67 | 67 | 67 | 62 | 0 | | | 6.04 | 1,565 | 25.2 | 2,680 | 2,580 |
| 265 | 100 | 97 | 91 | 79 | 72 | 67 | 58 | 40 | 0 | | | 6.04 | 761 | 11.9 | 3,070 | 2,690 |
| 266 | 100 | 97 | 93 | 88 | 83 | 67 | 50 | 27 | 7 | 0 | | 6.04 | 616 | 9.0 | 3,080 | 2,790 |
| 267 | 99 | 97 | 94 | 86 | 77 | 67 | 47 | 27 | 16 | | 0 | 6.04 | 709 | 10.5 | 3,150 | 2,710 |
| 268 | 98 | 95 | 90 | 83 | 83 | 83 | 50 | 22 | 0 | | | 6.04 | 834 | 12.6 | 3,080 | 2,500 |
| 269 | 98 | 94 | 90 | 86 | 83 | 80 | 55 | 18 | 0 | | | 6.04 | 898 | 13.3 | 3,050 | 2,550 |
| 270 | 96 | 90 | 80 | 80 | 80 | 80 | 60 | 39 | 0 | | | 6.04 | 1,391 | 21.5 | 2,970 | 2,550 |
| 271 | 100 | 96 | 92 | 87 | 81 | 75 | 50 | 23 | 0 | | | 6.04 | 672 | 10.0 | 2,930 | 2,710 |
| 272 | 95 | 91 | 87 | 82 | 77 | 73 | 59 | 40 | 0 | | | 6.04 | 1,315 | 20.2 | 3,000 | 2,580 |
| 273 | 99 | 95 | 88 | 80 | 76 | 73 | 61 | 32 | 0 | | | 6.04 | 911 | 13.9 | 2,950 | 2,740 |
| 274 | 90 | 85 | 81 | 78 | 75 | 73 | 66 | 56 | 0 | | | 6.04 | 1,992 | 31.3 | 2,680 | 2,440 |
| 275 | 100 | 93 | 82 | 73 | 73 | 73 | 63 | 47 | 0 | | | 6.04 | 1,076 | 16.7 | 2,820 | 2,620 |
| 276 | 100 | 100 | 100 | 92 | 81 | 60 | 45 | 26 | 0 | | | 6.04 | 390 | 5.6 | 3,040 | 2,780 |
| 277 | 100 | 98 | 95 | 90 | 80 | 60 | 50 | 31 | 0 | | | 6.04 | 557 | 8.3 | 2,900 | 2,770 |
| 278 | 100 | 99 | 96 | 92 | 84 | 55 | 50 | 28 | 0 | | | 6.04 | 483 | 7.0 | 2,940 | 2,750 |
| 279 | 100 | 99 | 96 | 91 | 80 | 50 | 50 | 38 | 0 | | | 6.04 | 514 | 7.6 | 3,080 | 2,750 |
| 280 | 98 | 84 | 84 | 84 | 84 | 57 | 57 | 57 | 0 | | | 6.04 | 1,276 | 19.7 | 3,000 | 2,780 |
| 281 | 99 | 98 | 91 | 86 | 80 | 76 | 38 | 38 | 0 | | | 6.04 | 701 | 10.4 | 2,940 | 2,700 |
| 282 | 99 | 98 | 91 | 86 | 80 | 76 | 46 | 30 | 0 | | | 6.04 | 697 | 10.2 | 3,020 | 2,660 |
| 283 | 99 | 98 | 91 | 86 | 80 | 76 | 61 | 15 | 0 | | | 6.04 | 689 | 10.1 | 2,930 | 2,670 |
| 284 | 99 | 98 | 91 | 85 | 80 | 76 | 67 | 8 | 0 | | | 6.04 | 685 | 9.9 | 2,970 | 2,630 |
| Average | | | | | | | | | | | | 6.04 | 904 | 13.8 | 2,990 | 2,690 |
| Minimum value | | | | | | | | | | | | | 390 | 5.6 | 2,680 | 2,440 |
| Maximum value | | | | | | | | | | | | | 1,992 | 31.3 | 3,300 | 2,890 |
| Mean variation from average—per cent | | | | | | | | | | | | | 34.4 | 37.2 | 3.41 | 3.04 |

Table II also furnishes some interesting data on the surface-area method of proportioning aggregates. It is seen that there is the widest variation in the surface area of the aggregate without any appreciable difference in the concrete strength. Our studies have shown that surface area is not a satisfactory basis for proportioning aggregates.

On the basis of the water ratio theory and of the

TABLE III. MAXIMUM PERMISSIBLE VALUES OF FINENESS MODULUS OF AGGREGATES

| Mix Cem.-Agg. | Size of Aggregate: 0-28 | 0-14 | 0-8 | 0-4 | 0-3* | 0-¾ | 0-¾* | 0-½ | 0-1 in.* | 0-1½ | 0-2.1* | 0-3 in. | 0-4½* | 0-6 in. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1-12 | 1.20 | 1.80 | 2.40 | 2.95 | 3.35 | 3.80 | 4.20 | 4.60 | 5.00 | 5.35 | 5.75 | 6.20 | 6.60 | 7.00 |
| 1-9 | 1.30 | 1.85 | 2.45 | 3.05 | 3.45 | 3.85 | 4.25 | 4.65 | 5.00 | 5.40 | 5.80 | 6.25 | 6.65 | 7.05 |
| 1-7 | 1.40 | 1.95 | 2.55 | 3.20 | 3.55 | 3.95 | 4.35 | 4.75 | 5.15 | 5.55 | 5.95 | 6.40 | 6.80 | 7.20 |
| 1-6 | 1.50 | 2.05 | 2.65 | 3.30 | 3.65 | 4.05 | 4.45 | 4.85 | 5.25 | 5.65 | 6.05 | 6.50 | 6.90 | 7.30 |
| 1-5 | 1.60 | 2.15 | 2.75 | 3.45 | 3.80 | 4.20 | 4.60 | 5.00 | 5.40 | 5.80 | 6.20 | 6.60 | 7.00 | 7.45 |
| 1-4 | 1.70 | 2.30 | 2.90 | 3.60 | 4.00 | 4.40 | 4.80 | 5.20 | 5.60 | 6.00 | 6.40 | 6.85 | 7.25 | 7.65 |
| 1-3 | 1.85 | 2.50 | 3.10 | 3.90 | 4.30 | 4.70 | 5.10 | 5.50 | 5.90 | 6.30 | 6.70 | 7.15 | 7.55 | 8.00 |
| 1-2 | 2.00 | 2.70 | 3.40 | 4.20 | 4.60 | 5.05 | 5.45 | 5.90 | 6.30 | 6.70 | 7.10 | 7.55 | 7.95 | 8.40 |
| 1-1 | 2.25 | 3.00 | 3.80 | 4.75 | 5.25 | 5.60 | 6.05 | 6.50 | 6.90 | 7.35 | 7.75 | 8.20 | 8.65 | 9.10 |

* Considered as "half-size" sieves; not used in computing fineness modulus.

For mixes other than those given in the table, use the values for the next leaner mix.

For maximum sizes of aggregate other than those given in the table, use the values for the next smaller size.

Fine aggregate includes all material finer than No. 4 sieve; coarse aggregate includes all material coarser than the No. 4 sieve. Mortar is a mixture of cement, water and fine aggregate.

This table is based on the requirements for sand-and-pebble or gravel aggregate composed of approximately spherical particles, in ordinary uses of concrete in reinforced-concrete structures. For other materials and in other classes of work the maximum permissible values of fineness modulus for an aggregate of a given size is subject to the following corrections:

(1) If crushed stone or slag is used as coarse aggregate, reduce values in table by 0.25. For crushed material consisting of unusually flat or elongated particles reduce values by 0.40.

(2) For pebbles consisting of flat particles, reduce values by 0.25.

(3) If stone screenings are used as fine aggregate, reduce values by 0.25.

(4) For the top course in concrete roads, reduce the values by 0.25. If finishing is done by mechanical means, this reduction need not be made.

(5) In work of massive proportions, such that the smallest dimension is larger than 10 times the maximum size of the coarse aggregate, additions may be made to the values in the table as follows: for ¾-in. aggregate 0.10; for 1½-in. 0.20; for 3-in. 0.30; for 6-in. 0.40.

Sand with fineness modulus lower than 1.50 is undesirable as a fine aggregate in ordinary concrete mixes. Natural sands of such fineness are seldom found.

Sand or screenings used for fine aggregate in concrete must not have a higher fineness modulus than that permitted for mortars of the same mix.

Crushed stone mixed with both fine sand and coarser pebbles requires no reduction in fineness modulus provided the quantity of crushed stone is less than 30% of the total volume of the aggregate.

TABLE IV. EXAMPLE OF INFLUENCE OF QUANTITY OF MIXING WATER ON THE STRENGTH OF CONCRETE

| Water in a 1-Bag Batch | | Relative Consistency | Compressive Strength of Concrete at 28 Days | |
|---|---|---|---|---|
| Gallons | Water-Ratio (x) | Per Cent. | Lb. per Sq.In. (S) | Relative Strength Per Cent. |
| 5.75 | 0.77 | 100 | 2,770 | 100 |
| 6.0 | 0.80 | 104 | 2,600 | 94 |
| 6.25 | 0.84 | 109 | 2,400 | 87 |
| 6.5 | 0.87 | 113 | 2,250 | 81 |
| 7.0 | 0.94 | 122 | 1,950 | 70 |
| 7.5 | 1.01 | 131 | 1,670 | 60 |
| 8.0 | 1.07 | 139 | 1,470 | 53 |
| 9.0 | 1.21 | 157 | 1,100 | 40 |
| 10.0 | 1.34 | 174 | 830 | 30 |
| 12.0 | 1.60 | 208 | 480 | 17 |
| 15.0 | 2.00 | 260 | 200 | 7 |

Values calculated from equation

$$S = \frac{A}{Bx} = \frac{14{,}000}{8.2x}$$

Where $S$ = compressive strength of concrete (lb. per square inch); $x$ = water ratio (an exponent).

$A$ and $B$ are constants whose values depend on quantity of cement and other conditions of the test. The values given for $A$ and $B$ are based on 28-day tests of 1:4 mix, pebble aggregate graded 0-1½-in., fineness modulus 5.75.

The water-ratio is equivalent to the cubic feet of water to 1 sack (1 cu. ft) of cement.

The strength values are solely for comparative purposes in showing the influence of changing the water content.

fineness modulus, as noted above, Professor Abrams' method of proportioning is then outlined as follows:

1. Knowing the compressive strength required of the concrete, determine by reference to Fig. 1 the maximum water-ratio which may be used. In general, some allowance must be made for the high strengths in laboratory tests. In other words, a water-ratio somewhat lower than that given for the required strength in Fig. 1 should be used. For convenience in the subsequent steps we shall deal with concrete strength instead of water-ratio (as in Fig. 6), although it should be understood that it is the water-ratio which fixes the strength so long as we have a plastic mix.

2. Make sieve analysis of fine and coarse aggregate, using Tyler standard sieves. Express sieve analysis in terms of percentages of material by weight (or separate volumes) *coarser than* each of the standard sieves.

3. Compute fineness modulus of each aggregate by adding the percentages found in (2), and dividing by 100.

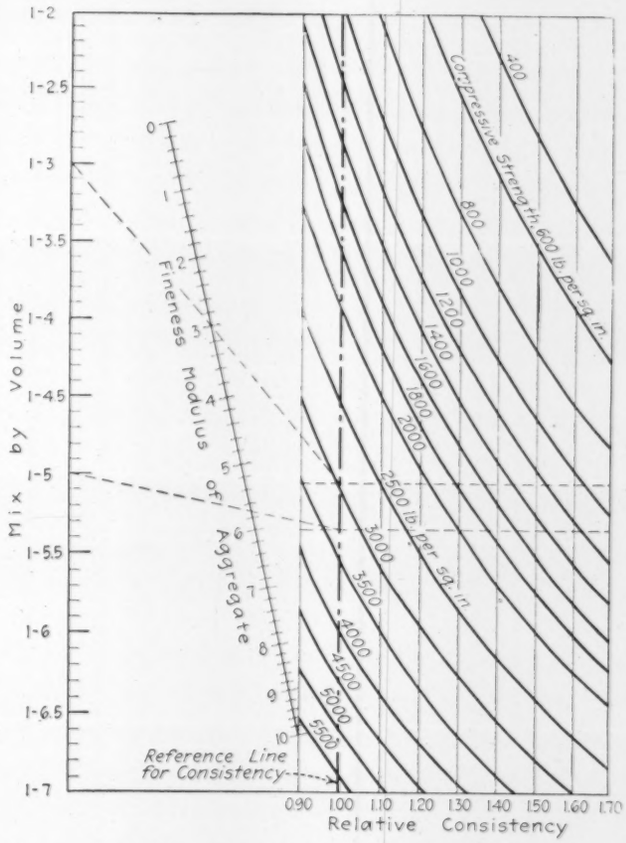



FIG. 6. DIAGRAM FOR DESIGN OF CONCRETE MIXTURES

Chart is based on compression tests of 6 x 12-inch cylinders at 28 days. Cement used gave strengths in 1:3 standard sand mortar, as follows:

| Age | Lb. per Square Inch |
|---|---|
| 7 days | 1900 |
| 28 days | 3200 |
| 3 mo. | 4200 |
| 1 year | 4360 |

TABLE V. QUANTITY OF MIXING WATER REQUIRED FOR CONCRETE

| Mix Cem.-Agg. by Volume | Gallons of Water per Sack of Cement Using Aggregates of Different Fineness Moduli | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.50 | 2.00 | 2.50 | 3.00 | 3.50 | 4.00 | 4.50 | 5.00 | 5.50 | 6.00 | 6.50 | 7.00 |
| | Relative Consistency — (R) = 1.00 | | | | | | | | | | | |
| 1-12 | 23.5 | 21.4 | 19.5 | 17.8 | 16.4 | 15.2 | 13.9 | 12.9 | 12.0 | 11.1 | 10.4 | 9.8 |
| 1-9 | 18.1 | 16.7 | 15.2 | 14.0 | 12.9 | 12.0 | 11.0 | 10.2 | 9.6 | 9.0 | 8.4 | 7.9 |
| 1-7 | 14.7 | 13.5 | 12.3 | 11.4 | 10.6 | 9.9 | 9.1 | 8.6 | 8.0 | 7.6 | 7.2 | 6.7 |
| 1-6 | 13.0 | 12.0 | 11.0 | 10.2 | 9.5 | 8.9 | 8.3 | 7.7 | 7.3 | 6.8 | 6.5 | 6.2 |
| 1-5 | 11.2 | 10.4 | 9.5 | 8.9 | 8.3 | 7.8 | 7.3 | 6.9 | 6.4 | 6.1 | 5.8 | 5.5 |
| 1-4 | 9.5 | 8.9 | 8.2 | 7.7 | 7.2 | 6.8 | 6.3 | 6.0 | 5.7 | 5.4 | 5.2 | 5.0 |
| 1-3 | 7.8 | 7.2 | 6.7 | 6.3 | 6.0 | 5.7 | 5.4 | 5.1 | 4.9 | 4.6 | 4.5 | 4.3 |
| 1-2 | 6.0 | 5.7 | 5.4 | 5.1 | 4.9 | 4.7 | 4.5 | 4.3 | 4.1 | 4.0 | 3.9 | 3.8 |
| 1-1 | 4.3 | 4.1 | 3.9 | 3.8 | 3.7 | 3.6 | 3.5 | 3.4 | 3.3 | 3.2 | 3.2 | 3.1 |
| | Relative Consistency — (R) = 1.10 | | | | | | | | | | | |
| 1-12 | 25.8 | 23.6 | 21.4 | 19.6 | 18.1 | 16.7 | 15.3 | 14.2 | 13.2 | 12.2 | 11.4 | 10.8 |
| 1-9 | 19.9 | 18.4 | 16.7 | 15.4 | 14.2 | 13.2 | 12.1 | 11.2 | 10.6 | 9.9 | 9.2 | 8.7 |
| 1-7 | 16.2 | 14.9 | 13.5 | 12.5 | 11.7 | 10.9 | 10.0 | 9.5 | 8.8 | 8.4 | 7.9 | 7.4 |
| 1-6 | 14.3 | 13.2 | 12.1 | 11.2 | 10.5 | 9.8 | 9.1 | 8.5 | 8.0 | 7.5 | 7.2 | 6.8 |
| 1-5 | 12.3 | 11.4 | 10.5 | 9.8 | 9.1 | 8.6 | 8.0 | 7.6 | 7.0 | 6.7 | 6.4 | 6.1 |
| 1-4 | 10.5 | 9.8 | 9.0 | 8.5 | 7.9 | 7.5 | 6.9 | 6.6 | 6.3 | 5.9 | 5.7 | 5.5 |
| 1-3 | 8.6 | 7.9 | 7.4 | 6.9 | 6.6 | 6.3 | 5.9 | 5.6 | 5.4 | 5.1 | 5.0 | 4.7 |
| 1-2 | 6.6 | 6.3 | 5.9 | 5.6 | 5.4 | 5.2 | 5.0 | 4.7 | 4.5 | 4.4 | 4.3 | 4.2 |
| 1-1 | 4.7 | 4.5 | 4.3 | 4.2 | 4.1 | 4.0 | 3.9 | 3.7 | 3.6 | 3.5 | 3.5 | 3.4 |
| | Relative Consistency — (R) = 1.25 | | | | | | | | | | | |
| 1-12 | 29.4 | 26.8 | 24.4 | 22.2 | 20.5 | 19.0 | 17.4 | 16.1 | 15.0 | 13.9 | 13.0 | 12.3 |
| 1-9 | 22.6 | 20.9 | 19.0 | 17.5 | 16.1 | 15.0 | 13.8 | 12.7 | 12.0 | 11.2 | 10.5 | 9.9 |
| 1-7 | 18.4 | 16.9 | 15.4 | 14.3 | 13.2 | 12.4 | 11.4 | 10.7 | 10.0 | 9.5 | 9.0 | 8.4 |
| 1-6 | 16.3 | 15.0 | 13.8 | 12.8 | 11.9 | 11.1 | 10.4 | 9.6 | 9.1 | 8.5 | 8.1 | 7.7 |
| 1-5 | 14.0 | 13.0 | 11.9 | 11.1 | 10.4 | 9.8 | 9.1 | 8.6 | 8.0 | 7.6 | 7.2 | 6.9 |
| 1-4 | 11.9 | 11.1 | 10.2 | 9.6 | 9.0 | 8.5 | 7.9 | 7.5 | 7.1 | 6.8 | 6.5 | 6.2 |
| 1-3 | 9.8 | 9.0 | 8.4 | 7.9 | 7.5 | 7.1 | 6.8 | 6.4 | 6.1 | 5.8 | 5.6 | 5.4 |
| 1-2 | 7.5 | 7.1 | 6.8 | 6.4 | 6.1 | 5.9 | 5.6 | 5.4 | 5.1 | 5.0 | 4.9 | 4.8 |
| 1-1 | 5.4 | 5.1 | 4.9 | 4.8 | 4.6 | 4.5 | 4.4 | 4.3 | 4.1 | 4.0 | 4.0 | 3.9 |

Calculated by Formula 4 in text.

In this table $(a - c)$ is assumed as 0.02. This value may be used for ordinary limestones and pebbles. For crushed trap and granite it is somewhat high. It is too high in any case where the aggregate is saturated with water.

A relative consistency of 1.00 (normal consistency) requires the use of such a quantity of mixing water as will cause a slump of ½ to 1 in. in a freshly molded 6 by 12-in. cylinder of about 1:4 mix upon withdrawing the form by a steady, upward pull. This consistency is somewhat dry for most concrete work, but can be used where light tamping is practicable.

A relative consistency of 1.10 (10% more water than required for normal consistency) represents about the driest concrete which can be satisfactorily used in concrete road construction. Under the conditions mentioned above, this consistency will give a slump of about 5 to 6 inches.

A relative consistency of 1.25 represents about the wettest consistency which should be used in reinforced concrete building construction. Under the conditions mentioned above, this consistency will give a slump of about 8 to 9 inches.

For mixes and fineness moduli, other than those given in the table, approximate values may be determined by interpolation. For specific cases use the formula.

4. Determine the "maximum size" of aggregate by applying the following rules: If more than 20% of aggregate is coarser than any sieve the maximum size shall be taken as the next larger sieve in the standard set; if between 11 and 20% is coarser than any sieve, the maximum size shall be the next larger "half-sieve"; if less than 10% is coarser than certain sieves, the smallest of these sieve sizes shall be considered the maximum size.

5. From Table III determine the maximum value of fineness modulus which may be used for the mix, kind and size of aggregate, and the work under consideration. (The values in Table III are platted in Fig. 5.)

6. Compute the percentages of fine and coarse aggregates required to produce the fineness modulus desired for the final aggregate mixture by applying the formula:

$$p = 100\,\frac{A-C}{A-B} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where $p$ = percentage of fine aggregate in total mixture.
$A$ = fineness modulus of coarse aggregate.
$B$ = fineness modulus of final aggregate mixture.
$C$ = fineness modulus of fine aggregate.

Fig. 7 may be used for solving Eq. (3), and for making comparisons of the effect of certain changes in proportions

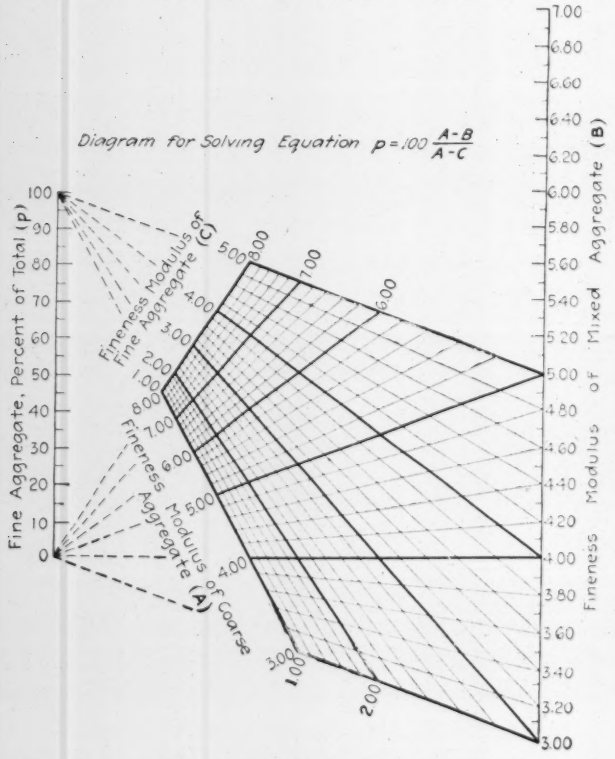


Diagram for Solving Equation p=100 A-B/A-C
Fine Aggregate, Percent of Total (p)
Fineness Modulus of Coarse Aggregate (A)
Fineness Modulus of Fine Aggregate (C)
Fineness Modulus of Mixed Aggregate (B)

FIG. 7. DIAGRAM FOR DETERMINING QUANTITY OF SAND REQUIRED IN CONCRETE MIXES

of fine and coarse aggregates. The distinction between fine and coarse aggregate is solely for convenience in securing a uniform grading; the division may be made at any desired point.

7. With the estimated mix, fineness modulus and consistency enter Fig. 6 and determine the strength of concrete produced by the combination. If the strength shown by the diagram is not that required, the necessary readjustment may be made by changing the mix, consistency or size and grading of the aggregates.

The quantity of water required can be determined from Eq. (4) below, or approximately from Table V.

It must be understood that the values in Fig. 6 were determined from compression tests of 6 x 12-in. cylinders stored for 28 days in a damp place. The values obtained on the work will depend on such factors as the consistency of the concrete, quality of the cement, methods of mixing, handling, placing the concrete, etc., and on age and curing conditions. Strength values higher than given for relative consistency of 1.10 should seldom be considered in designing, since it is only in exceptional cases that a consistency drier than this can be satisfactorily placed. For wetter concrete much lower strengths must be considered.

Because of the important influence of the quantity of water in the concrete it is desirable to have a sound basis for proportioning the water. The quantity of water necessary for given proportions and conditions may be determined by the following formula:

$$x = R\left[\frac{3}{2}p + \left(\frac{.30}{1.26^{m}} + a - c\right)n\right] \qquad \ldots\ldots\ldots (4)$$

where

$x$ = water required—ratio to volume of cement in batch (water-ratio).

$R$ = Relative consistency of concrete, or "workability factor." Normal consistency (relative consistency = 1.00) requires the use of such a quantity of mixing water as will cause a slump of ½ to 1 in. in a freshly molded 6 x 12-in. cylinder of about 1:4 mix upon withdrawing the form by a steady, upward pull. A relative consistency of 1.10 requires the use of 10% more water and under the above conditions will give a slump of about 5 to 6 inches.

$p$ = Normal consistency of cement, ratio by weight.

$m$ = Fineness modulus of aggregate (an exponent).

$n$ = Volumes of mixed aggregate to one of cement.

$a$ = Absorption of aggregate, ratio of water absorbed to volume of aggregate. (Determined after immersion in water for three hours. Average values for crushed limestone and pebbles may be assumed as 0.02; porous sandstones may reach 0.08; very light and porous aggregate may reach 0.25.)

$c$ = Moisture contained in aggregate, ratio of water contained to volume of aggregate. (Assume as zero for room-dry aggregate.)

This formula takes account of all the factors which affect the quantity of water required in a concrete mixture. These factors may be classified as follows:

1. "Workability" factor, or the relative consistency of the concrete. This is dictated by the kind of work being done; concrete must be more plastic (which generally means a wetter consistency) in reinforced-concrete building construction than is necessary in mass work. The term ($R$) in the equation takes care of this factor. ($R$) may vary from, say, 0.90 for a dry concrete to 2.00 or higher for very wet mixes.

2. Cement factor, which is made up of two parts: the *quality* of cement so far as normal consistency is concerned ($p$); the *quantity* of cement in the mix ($n$).

3. The aggregate factor. This includes the three terms within the parenthesis in Eq. (4). The first term, involving ($m$), takes account of the size and grading; the second ($a$) the absorption, and the third ($c$) the water contained in the aggregate.

While Eq. (4) represents the true water relation, it is somewhat complicated by the fact that the fineness modulus ($m$) appears as an exponent. The equation can be expressed in a simpler form as follows:

$$x = R\left[\frac{3}{2}p + (0.22 - \frac{m}{42} + a - c)\,n\right] \qquad \ldots\ldots (5)$$

This equation gives values for ordinary ranges of mix and grading of aggregate which are sensibly the same as given by Eq. (4).

Since a maximum practicable value of fineness modulus is found for each size of aggregate and mix, it is necessary to place certain limits on the value which may be used for proportioning materials for concrete mixes. Table III gives limits which will be found practicable. Subsequent experience may dictate certain modifications in the details.

The purpose of Table III is to avoid the attempt to secure an aggregate grading which is too coarse for its maximum size and for the amount of cement used. It is also useful in prohibiting attempts to use sands which are too coarse for best results in concrete mixtures. For instance, it would be found from this table that the use of a sand of

he nature of standard Ottawa sand is not permitted except in mixes 1:2 or richer.

The curves in Fig. 5 are platted directly from the values given for the standard sieves in Table III.

Fig. 6 is a nomographic chart for the design of concrete mixes. This chart takes account of the following four factors: (1) The mix (cement content); (2) the relative consistency; (3) the grading of aggregate (fineness modulus); (4) the compressive strength of concrete.

Given any three of these factors, the chart enables us to solve for the fourth. This chart is, of course, based on the results of certain tests. For practical application these values must generally be reduced by certain factors, which will depend on the judgment of the designer. In order to furnish some basis for comparison, compression tests of 1:3 standard sand mortars from the cement used in these tests are given.

Suppose we consider the case of concrete for road construction. This is generally specified as a 1:1½:3 or a 1:2:3 mix, with aggregate graded up to 1½ in. These mixes are about the same as what have been termed a 1:4 mix, the exact equivalent depending on the particular size and grading of the fine and coarse aggregate. Assume that gravel aggregate will be used, graded to 1½ in. Table III shows that we may use a fineness modulus as high as 6.00 — .25 = 5.75. Knowing the sieve analysis and fineness modulus of both sizes of aggregate, apply the formula or Fig. 7 to determine the proportions of each aggregate which must be mixed to secure this value. Assume that the concrete will be mixed to a relative consistency of 1.10, which is of such plasticity as will give a slump of 5 to 6 in. in the test described above. Place a straightedge in Fig. 6 on mix 1:4 and fineness modulus 5.75, and mark the point where it crosses the reference line for consistency; from this point project the line horizontally (as indicated in other examples) to relative consistency 1.10. It will be seen that this gives a compressive strength of 3,400 lb. per square inch at 28 days.

The effect of using other mixes, gradings or consistencies on the strength can be seen at once from the diagram. For instance, if the water were increased to a relative consistency of 1.25 (not nearly so wet as is frequently seen in road work) the strength will be reduced to 2,700 lb. per square inch—a reduction of over 20%. If the mix were changed to 1:4½ and other factors the same as in the first example, the strength would be 3200 lb. per square inch. We should have to change the mix to as lean as 1:5¼ in order to secure the same reduction in strength as was found above for a change from 1.10 to 1.25 consistency.

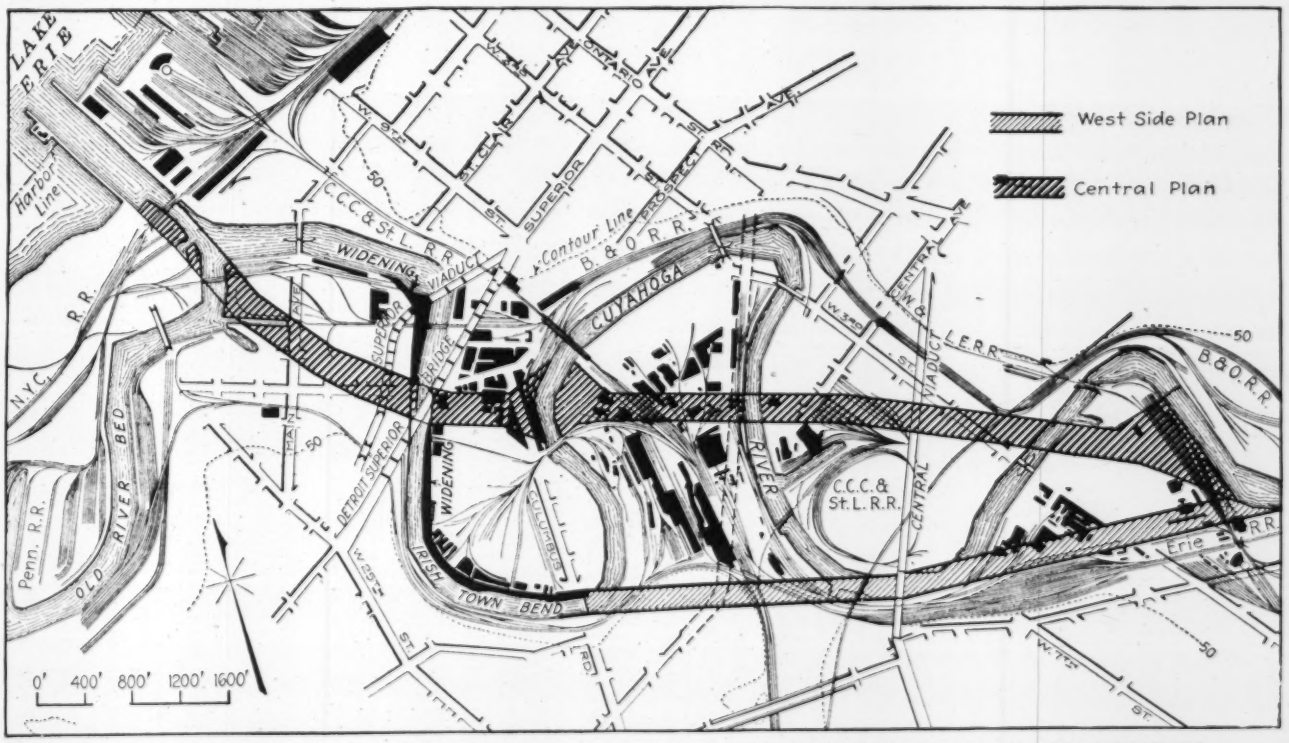
By using the wetter of the two consistencies we secure concrete of the same strength as if we had used one-third less cement and the drier mix. In other words, increasing the mixing water 13% causes the same reduction in strength as if we should omit 33% of the cement. This example shows the reason for emphasizing the importance of proper control of mixing water in concrete.

Eq. (4) and (5) show the elements which make up the water-requirements of a concrete mix. Table V gives the quantity of water required for certain mixes and values of fineness modulus. Quantities are given in terms of gallons per sack of cement. In this table the net absorption (that is, the quantity of water taken up by the aggregate in addition to that already contained) is assumed as 0.02 (2% by volume).

# New River-Straightening Movement at Cleveland

## Conservancy District Proposed — Choice Between Central and West Channels Affected by Union Station Scheme

STEPS have been taken by the county commissioners of Cuyahoga County, Ohio, in which the City of Cleveland is situated, to bring about the formation of a conservancy district under the Ohio conservancy law, in order to carry out the work of straightening the Cuyahoga River. A court hearing on the commissioners' petition that such a district be formed will be held Apr. 18. In 1913 the river flooded the valley bottom land sufficiently to do damage estimated variously up to $3,000,000. Numerous plans for straightening the river had been proposed before that time and others were developed subsequently, the object being improvement of navigation, but after 1913 the advan-




LOWER CUYAHOGA RIVER IN CLEVELAND, WITH ROUTES OF TWO RIVER-STRAIGHTENING PROJECTS

tage of straightening with a view to reduction of floods by increasing the channel capacity was also taken into account. As indicated on the sketch map herewith, the sharp bends of the river windings form a serious obstacle to navigation, their effect being made more serious by various low-level bridges, and at the same time they reduce the flow capacity.

A new factor was injected into the case two years ago by the vote of the people of the county appropriating money for a viaduct connecting Lorain Ave. on the west side with Huron Road on the east. As the referendum vote has been interpreted, a practically straight alignment of the viaduct between the ends of the two streets must be maintained, and this involves an unfavorable relation to the river. Doubt as to whether the construction of the bridge on this location is advisable while the river remains in its present condition led to delay in preparation of plans and initiation of work on the structure, and ultimately brought about the petition to the county court for the formation of a conservancy district.

Of the straightening projects now considered favorably, the two principal ones are those indicated on the map. The central one was worked out in 1916 and 1917 by a committee composed of E. B. Thomas, consulting engineer, W. A. Stinchcomb, county engineer, Robert Hoffmann, city engineer, and Maj. P. S. Bond, United States Engineer Officer. It is perhaps the most radical of the projects devised. Since it was prepared with the coöperation of a representative of the Engineer Corps, it has commonly been called the Federal plan.

A considerable amount of local sentiment, however, favors the west side plan, also shown on the map. This is composed of two sections, the northerly part being locally known as Plan No. 2, which is favored by the City Planning Commission, while the southerly extension is called the Mahoning Ave. cut. North of the Plan No. 2 channel a certain amount of river widening would be done to make the channel more easily navigable at the bends and to increase its flow capacity.

### Believe One or Other of Plans Proposed Will Be Adopted

If a conservancy district is organized its studies would necessarily be general and not be limited to the two here shown. Cleveland engineers familiar with the river problem are, however, of the opinion that one or the other of the plans shown will almost necessarily be selected. The cost of the two projects was estimated something over two years ago at about $7,000,000 for the central channel and a trifle less than $5,000,000 for the west side channel as shown.

Until the formulation of the new union station project last autumn, which involves removal and relocation of many of the railway tracks and yards in the Cuyahoga valley, a serious obstacle to the realization of the west side channel scheme was the existence of important yards on or adjacent to the location of the channel. It is believed that with the removal of these yards through their replacement by yards in other parts of the city, in connection with the union station project (now planned to combine all roads in a passenger station on the public square and to rearrange freight facilities), the chief objections to the west side channel are removed, and its advantages in affecting a minimum of industrial property are held to be an important argument in its favor.

## Operation Cost, Municipal Asphalt Plant of the District of Columbia

ITEMIZED costs for the operation of the District of Columbia municipal asphalt plant are contained in a report by the engineer department for the year which ended June 30, 1918. The plant output for the year was 185,952 cu.ft. of material, consisting of 151,152 cu.ft. of old-material mixture, 22,056 cu.ft. of asphaltic concrete mixture, and 12,744 cu.ft. of topping mixture. The plant was operated for 214 days with an average daily output of 869 cubic feet.

Hauling by motor truck was introduced during the year for hauling the hot mixture, and was found to be both economical and advantageous. About 90% of the hot haul is being done by trucks at the present time, replacing the horse-drawn carts and wagons.

MUNICIPAL ASPHALT PLANT COSTS AT WASHINGTON, D. C.
Based on 1 Cu.Ft. of Mixture

| | | |
|---|---|---|
| *Old-Material Mixture* | | |
| Material cost: | | |
| Old material, 0.6 cu.ft., at $1.05 per cubic yard | | $0 0233 |
| Sand, 0.34 cu.ft. at $1.43 per cubic yard | | 0180 |
| Limestone dust, 2.1 lb. at $3.63 per ton | | 0038 |
| Asphaltic cement, 4.12 lb. at $19.10 per ton | | 0393 |
| Total cost of material per cubic foot | | $0 0844 |
| Manufacturing and placing cost: | | |
| Plant labor | $0 0593 | |
| Hot haul | 0498 | |
| Street laying | 1974 | |
| Maintenance of plant and tools | 0188 | |
| Supervision | 0432 | |
| Total | | $0 3685 |
| Total cost per cubic foot | | .4529 |
| *Asphaltic Concrete Mixture* | | |
| Material cost: | | |
| Screenings, 0.5 cu.ft., at $1.30 per ton | | 0331 |
| Sand, 0.5 cu.ft., at $1.43 per cubic yard | | 0265 |
| Limestone dust, 4.2 lb., at $3.63 per ton | | 0076 |
| Asphaltic cement, 9.16 lb., at $19.10 per ton | | 0875 |
| Total cost of material | | $0 1547 |
| Manufacturing and placing cost | | .3685 |
| Total cost per cubic foot | | $0 5232 |
| *Topping Mixture* | | |
| Material cost: | | |
| Sand, 1.0 cu.ft., at $1.43 per cubic yard | | $0 0530 |
| Limestone dust, 4.2 lb., at $3.63 per ton | | 0076 |
| Asphaltic cement, 9.16 lb., at $19.10 per ton | | 0875 |
| Total cost of material | | $0 1481 |
| Manufacturing and placing cost | | 3685 |
| Total cost per cubic foot | | $0 5166 |

A summary of the costs of material, operation, hauling, laying, maintenance and supervision is given in the table. The cost of minor repairs to sheet-asphalt pavements during the year averaged 1.7c. per square yard on a yardage of 3,064,706. The average costs for the past 10 years have been as follows: 1908, 3.8c.; 1909, 2.3c.; 1910, 2.6c.; 1911, 2.2c.; 1912, 2.4c.; 1913, 2c.; 1914, 1.9c.; 1915, 1.9c.; 1916, 1.8c.; 1917, 1.5c. The municipal asphalt plant began operations in 1912.

## Heaviest Rapid Transit in New York City

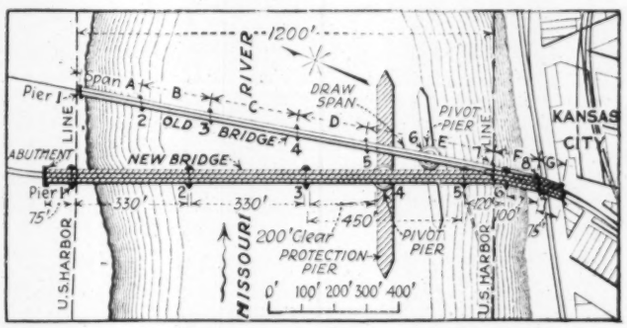
Record-breaking traffic on the New York rapid-transit lines occurred on Mar. 24 and 25, due to military reviews held in New York and Brooklyn. On Mar. 24, 1,824,735 passengers were carried on the subways of Manhattan Borough, and 1,332,607 passengers on the elevated lines of the same borough, making a total of 3,157,342. On Mar. 25 the corresponding figures were 1,753,772, 1,122,894 and 2,876,666. The latter figure is in excess of any previous record up to the day before. An unusually heavy traffic was also carried on the Brooklyn elevated lines, a few of these showing record-breaking figures.

# Dismantle Bridge Spans Carefully for Use Elsewhere

## Old Missouri Bridge of Burlington Railroad Is Removed—Drawspan Tied to Pivot Pier While End Panels Are Cut Off

REMOVAL of the old Missouri River bridge of the Chicago, Burlington & Quincy R. R., in 1916-17, was complicated by partial overlapping of the new bridge—which necessitated alterations under traffic—and by the requirement that the work should be done with such care as to permit re-erecting the spans at other sites. High water made it desirable to omit falsework at some points and compelled its omission at two spans. In dismantling the drawspan, cables anchored to the floor system held the span balanced on the pivot pier while corresponding members were removed simultaneously from opposite ends of the span.

This work followed the construction of a new bridge




LOCATION OF OLD AND NEW BRIDGES AT KANSAS CITY

partly alongside and partly on the same location, the old and new bridges forming a V, with the point on the south shore. At this point the approach is practically fixed, as it lies along a steep bluff with a high retaining wall protecting the tracks and through a cut on a heavy reverse curve. This made the center lines nearly identical for about 150 feet.

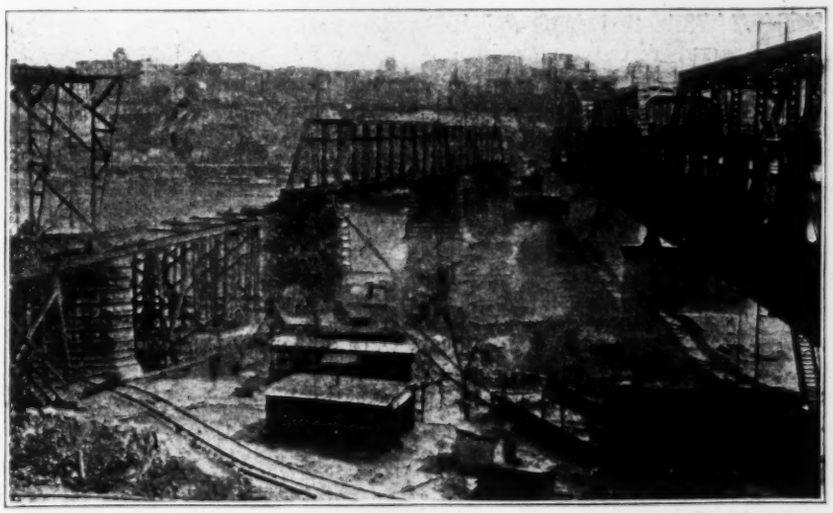
The old structure was known as the Hannibal bridge, having been built by the Hannibal & St. Joseph R.R. in 1867-69. Its original Howe trusses had been replaced at various times by steel spans. The arrangement from north and south was as follows: Four through truss spans of 177 ft., 200 ft., 250 ft. and 199 ft.; through truss swing span of 363 ft.; through truss span of 130 ft., through girder span of 69 ft. Dismantling the two south spans under traffic was necessary from the fact that they interfered with the new bridge. The other five spans were removed after traffic had been transferred to the new bridge. The relative positions of the old and the new bridges are shown by the plan. For the 69-ft. girder span, falsework was built downstream to permit rolling it out, which was done by a hoisting engine mounted on a flat-car on a track which passes under the bridge, the engine operating two sets of triple-blocks with 1¼-in. manila cables. The falsework was extended upstream to carry the new girder span, which was pulled into position in the same way.

The use of pile falsework was not advisable for the removal of the 130-ft. truss span, because of loose rock and shale dumped beneath the span, and of the danger from high water. Two heavy frame bents set on the concrete footing of the new pier No. 6 supported four 75-ft. deck girders, whose outer ends were carried on a timber grillage on a limestone ledge near pier No. 7. The bents were anchored to the shaft of the pier by dowels, and were high enough to allow for a 20-ft. rise in the river. Frame bents on the girders were placed under the panel points, and falsework stringers and blocking were placed on these.

As the old span extended about 40 ft. over new pier No. 6, a set of old 44-ft. girders was set between new pier No. 6 and old pier No. 7, to serve as falsework during the wrecking of the span and also to carry the traffic as long as the old bridge was in service. The old single track was connected at the south end of the draw with the outbound track on the new double-track through girder span which was then in place. This gave a dead-end spur on which the derrick car stood while taking down the old trusses and loading the members onto flat-cars placed behind it. From the crane boom was hung the ram with which the truss pins were driven out.

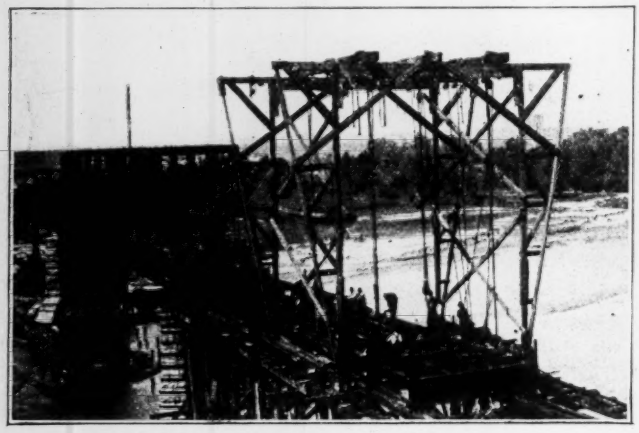
Removal of the old drawspan was the first proceeding as soon as the new structure had been opened to traffic, for until it was partly removed it was impossible to place the 120-ft. deck girders between the new piers Nos. 5 and 6, and to complete the double track. The use of falsework was dispensed with as a matter of economy and to avoid danger from high water. Four lines of ⅞-in. cable were run at about 45° from the floor-beam of the second panel point on each side of the center panel and anchored to the pivot pier. In the dismantling, similar pieces were removed from each end at the same time, keeping the span balanced on the pier by means of the cables.

By blocking up on the downstream protection crib of the new pivot pier, and using this pier as falsework, the crane from the north end was run out on the second



MIDDLE SPANS WERE LEFT UNTIL THE LAST ON ACCOUNT OF HIGH WATER—AT THE RIGHT IS THE NEW BRIDGE

panel of the old draw. Five panels were removed by this crane and three by a crane on the south end. For this work 60-ton erecting cranes were used, fitted with 75-ft. booms. They loaded the steel on flat-cars placed behind them. The north crane stood on the old span D. The south crane worked from the outbound track, standing on the 44-ft. falsework girders between the old



TRAVELER IS USED FOR REMOVING TRUSS SPANS

pier No. 7 and the new pier No. 6. The remaining panels were removed by a 100-ft. steel boom rigged to a post of the new span and operated by a hoisting engine anchored on the outbound track, which had not been put in service at that time.

For removal of the fixed spans north of the draw, it had been intended to drive falsework and remove them in order, beginning at the draw, thus using the old track connection to handle the material. A rapid rise in the river, however, washed out several bents driven under span D, and the contractor decided to wait until all danger of spring high water was over. As this would have seriously delayed removal of the old piers, the railway company assumed part of the additional cost of removing spans C and D, and the contractors agreed to remove spans A and B at once.

A light overhead traveler was built on the job and erected on falsework placed under span B, this being outside the main current and in little danger from high water. While this span was being dismantled, frame bents were erected under span A, using five yellow-pine piles as posts in each bent. The same traveler removed this span and loaded the material on cars. This work had released piers 1 and 2 for wrecking, and as the river was still too high to permit driving piles in the channel, the removal of spans C and D was left until early in the fall of 1917.

Falsework piles were 70- to 80-ft. yellow-pine sticks. Those for span D were driven by a steam hammer in leads erected on a barge, while those for span C, where the water was only about 1 ft. deep, were driven by the same hammer in leads suspended from the top laterals. As the material was removed by the traveler it was run on a push-car to the north end of span C and loaded into cars by a stiffleg derrick set up on short piles and having an 80-ft. stick for a boom. The heaviest sections were end posts weighing about 3¾ tons.

Piles under span D were pulled by a triple block on a short boom rigged up on the barge. Those under span C, in an exposed sand bar, were pulled by a hoisting engine on the ground using a triple block hung from a gin-pole. This consisted of a 60-ft. pile with its lower end set on a short stringer and the top held by guys. The stringer was skidded from bent to bent.

Care in removing the spans was required by the contract, as the bridge department of the railroad intends to erect all the spans over other streams. It even specified the drilling out of rivets if necessary to prevent injury to the metal. Driving nuts were specified for removing pins, but most of these had been cut so badly by the eyebars, some to a depth of ¼ in., that new pins will be required in reërecting the spans. The parts were matchmarked by the contractors and were shipped to the railroad shops at West Burlington, Iowa. There they are being worked over, parts of the floor systems which were badly rusted being replaced. The drawspan will be converted into simple spans. Removal of the substructure will be described in a separate article. The superstructure was taken down by the American Bridge Co., under the direction of G. A. Haggander, bridge engineer of the Chicago, Burlington & Quincy R.R., with H. W. Smith as resident engineer.

# Highway Bridge Piles Concreted to Avoid Replacing

## Work Accomplished Without Interruption of Traffic When Piles Had Been Practically Destroyed by Teredos

By F. E. Semon
City Engineer, Port Angeles, Wash.

COMPLETE reconstruction of the pile foundation of a long wooden highway trestle which had been honeycombed by teredos, and the consequent interruption of highway traffic, were avoided by casing the affected portions in concrete. The bridge was a 2000-ft. connection across the bay at Port Angeles, Wash., and, being the only route, it was necessary to keep it open for traffic. Inspection showed that the piles were nearly eaten away at the ground line, there being only about 4 in. of riddled wood at the center. Instead of trying to renew them, it was decided to place the con-

FIG. 1. FORMS BOLTED TOGETHER AROUND PILES READY FOR CONCRETNG AT LOW TIDE

crete, thus protecting them from further ravages by the borer. Untreated piles last here only about three years.

In the placing of the casings, all work was carried on from the bridge floor. Sand and gravel were obtained from the beach near by, mixed in proper proportions, loaded in dump wagons and conveniently distributed on the floor. Cement was stored in small knockdown sheds, and water was provided by a 6-in. water main resting on brackets under the bridge, the pipe being tapped at suitable intervals.

The forms, which are shown in an accompanying illustration, were designed so as to be knocked down easily, and were constructed of 1-in. boards dressed on one side and nailed to 2 x 4-in. pieces. Four ½-in. iron rods were passed through the 2 x 4-in. pieces and tightly drawn up by nuts at either end, to hold the frames together. The inside faces of the forms received a heavy coat of black oil. The forms were 2 ft. square, inside measurement, and a piece of 4 x 4-in. timber sawed diagonally was nailed in the corner. It was found that forms not more than 6 ft. in length were the most convenient; if necessary they were extended after the first length had been filled with concrete.

Placing of the forms was accomplished at low tide, and the filling was done during the 8-hour period of lowest tide. It was afterward found that suitable wood

FIG. 2. PILES WERE HONEYCOMBED BY TEREDO AND COVERED WITH BARNACLES BEFORE REPAIR

yokes made from 2 x 3-in. material and of such size that they could be wedged around the outside of the forms, thus drawing them together, were much easier to erect, adjust and knock down than bolted forms. The forms were braced to the piles to keep them from floating at high tide.

Concreting was done with a small mixer, the proportions being one part of cement to five of aggregate. Each batch was turned for about 1 min., or until a very thorough mixture was obtained, and wheeled in barrows to the chute that led into the form around the pile.

The complete force consisted of nine men, one to handle the sand and gravel, one to put in the cement and water and run the mixer, two to wheel the mixed concrete to the chute, one to tamp the concrete in the forms, one carpenter and two helpers to erect the forms, and a foreman. All work was done by city force account.

The sand and gravel cost 60c. per cubic yard, delivered. The cement cost $2.45 net per barrel, and the rental of the concrete mixer, including the operator, gasoline and oil, was $5 per day. The laborers were paid $3 per 8-hour day and the foreman was paid $4. In all, 222 piles were concreted, with an average length of 7 ft.; the cost per pile was $7. The cost of concrete in place per cubic yard, including the cost of form setting, was $10.

Every effort was used to get dense concrete, not only to support the bridge, but also to overcome further destruction by teredos. Thus far results have been very satisfactory. The base of the jackets extended to 1 ft. below the ground and the top to a point slightly above ordinary high-water mark.

## Baths', Pressure and Pipes' Influence Effect of Water Meters

THREE factors which may have an important bearing on the effect of metering upon the water consumption, but which are seldom taken into account, are noted by H. P. Matte, chief sanitary engineer of the Illinois State Department of Public Health, in a recent paper presented to the Western Society of Engineers. The three factors are as follows: Pressure upon the water system; extent of house connections with sanitary sewers, especially the use of bathtubs and water closets; effective size of mains and services.

The average pressure is rarely included in comparing per capita rates of consumption, says Mr. Matte, although in cities with higher pressure the leakage rate both through fixtures and underground piping will be greater than in those which maintain a lower average pressure. In Oak Park, Ill., the per capita consumption is varied between 1 and 2 gal. for each pound of change in pressure. That is, variation of 10 lb. either way will make a difference of 10 to 20 gal. per capita daily. Thus, the Oak Park rate of 65 gal. at 45-lb. pressure can be reduced to 45 gal. at 25 lb. In Niagara Falls, N. Y., where the rate was 300 gal., exclusive of the industrial use, Mr. Matte determined this rate to be from 3 to 5 gal. per pound change in pressure, or 30 to 50 gal. per capita for each 10-lb. change.

Consumers having faucets only are seldom classified separately from those having all the sanitary conveniences. In Oak Park it was determined that where no leaks or waste existed the average consumption per capita was 20 gal. for water closets and 15 gal. for bathtubs. A person who takes a cold bath every morning is likely to consume 40 gal. per day in this item. Low pressure and consequent increase in time required to fill the tubs often reduces the consumption for baths.

Limited services and sanitary facilities in foreign cities, cutting down the number of outlets for consumption and fixture leakage, are mainly responsible for their low per capita consumption, according to Mr. Matte. Figures obtained three or four years ago indicated that some European cities of over 2,000,000 population had about as many service connections as the average city of 300,000 in this country, while the number of services in foreign cities of about 350,000 equalled that of our cities of 40,000.

Loss of pressure by friction from the reduced area of corroded lime-coated service pipes and pipes filled with algæ, crenothrix and tubercles, indicates the importance of the effect of size of service pipes and mains on leakage and waste. Water bills on metered premises in which leakage and waste exist often double in size after the renewal of service pipes, both in the ground and in the interior of the house, especially when iron pipe has been replaced.

# New Methods for the Solution of Backwater Problems

## Use of Diagrams With Only One Major Variable Reduces Computations and Leads To More Accurate Results

By H. R. Leach
Saginaw, Mich.

COMPUTING the amount and determining the profile of water backed up behind an obstruction in a stream is one of the most difficult problems with which the hydraulic engineer is confronted. The complicated conditions which arise in actual practice,

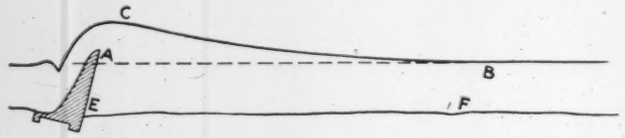



FIG. 1. OUTLINE OF A TYPICAL BACKWATER CURVE

coupled with the numerous variable factors which affect the results, often lead the engineer into a maze of calculations which render complete solution far from easy. It is the purpose of the present paper to explain some methods of treating this problem which the writer has found helpful in eliminating some of the more tedious parts of the computation, and which he believes will lead to more accurate and complete results.

A simple case of backwater is shown in Fig. 1. EF is the bed of a stream channel and AE represents a spillway or other obstruction placed across the channel at E. Under normal channel conditions, with no obstruction at E, the water-surface profile for a given discharge is shown by AB. With the obstruction in place the water-surface profile for this same discharge is shown by CB. The difference in elevation between these two profiles is the amount of backwater caused by the obstruction for the given flow. The usual method of determining the profile CB consists of dividing the channel upstream from the obstruction into reaches, computing the fall through each reach by means of slope calculations, and with this data plotting the backwater profile. The equation to be used in computing slopes through the reaches will be considered first.

The writer has adopted Manning's modification of Kutter's formula for the flow of water in an open channel, but this method is not confined to the use of this formula. Any discharge formula of the type $v = Cr^a s^b$ may be used provided $C$ does not vary with $s$, so that it is adapted to either Bazin's or Manning's formula, or to some of the more recent exponential formulas. For a justification of the use of Manning's formula and a comparison with Kutter's formula, the reader is referred to the excellent discussion of this formula in King's "Handbook of Hydraulics." The coefficient of roughness in this formula is in most cases identical with that in the Kutter formula, and the engineer in adopting it can still think of channel roughness in terms of $n$.

By Manning's formula

$$v = \frac{1.486}{n} r^{\frac{2}{3}} s^{\frac{1}{2}}$$

in which $n$ is identical with Kutter's $n$. For any short reach of a channel there is a definite relation between the depth of water in the channel, the discharge through the channel, and the slope of the water surface required to give this discharge, so that if any two of these quantities are known the third is also determined. The discharge of an open channel using Manning's formula equals

$$Q = CAr^{\frac{2}{3}} s^{\frac{1}{2}}$$

in which $C = 1.486/n$. For any given channel of uniform cross section $CA_r^{\frac{2}{3}}$ is a definite quantity for a given depth, as it is dependent only on the size and shape of the cross-section of the channel, hence a curve can be drawn showing the values of this quantity corresponding to any assumed depth. This quantity $CAr^{\frac{2}{3}}$ has been called $K_d$ to indicate a quantity varying only with the depth of water in the channel. Substituting in Manning's formula $Q = K_d s^{\frac{1}{2}}$, this equation is readily solved by a logarithmic diagram. Fig. 5, in which the $Q$ lines are parallel, with a slope equal to $\frac{1}{2}$, and spaced on any $s$ line in proportion to values of $K_d$. Only the $Q$ lines corresponding to the discharges to be used in the problem need be drawn, though a complete diagram once drawn can be used in any problem.

The practical advantage in the use of the factor $K_d$ is that this one quantity replaces three other variables, and thus eliminates the necessity for any further consideration of them, when it has once been computed. Besides this, it gives a direct index to the carrying capacity of the channel having the given cross-section and might well be called a "type curve" of the cross-section. Aside from the backwater problem, the writer believes that this curve may be adopted to advantage in many other fields of open-channel computation.

In solving the backwater problem, it is first necessary to divide the stream above the obstruction into reaches of suitable length. Each reach should be selected so that the channel conditions throughout its

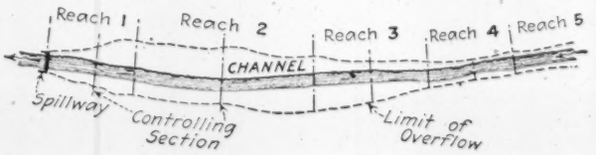



FIG. 2. METHOD OF DIVIDING A STREAM INTO REACHES

length are as uniform as possible and so that it may be fairly represented by one typical cross-section. The cross-section area of the stream determines the surface slope required for a given discharge, and hence any material change in this area, either through restriction of the channel or change in the depth of the water, will change the slope. With a slight slope, however, there may be considerable change in slope without material change in the total fall through the reach, so that in that portion of the stream near the obstruction where the slopes are comparatively flat, longer reaches may be used.

After the reaches have been chosen, the next step is the selection of a typical cross-section for each reach. For this it is desirable to use the average of several cross-sections of the stream in the reach, but where this is not possible care should be exercised to select a section representative of the entire length of reach. When the controlling sections have been selected, the $K_d$ curve is drawn for each section, Fig. 4. This is done by determining the area and hydraulic radius for several depths covering the probable range in stage of water surface, and computing the value of $K_d$ for each of these

depths from the equation $K_d = CAr^{\frac{2}{3}}$. Only enough values need be computed to determine the curve for each section.

In order to start the backwater calculations, the elevation of the water surface at the point of obstruction for the given or assumed discharge should be determined. If the obstruction is a weir or an overflow dam, the discharge curve for the dam is easily com-

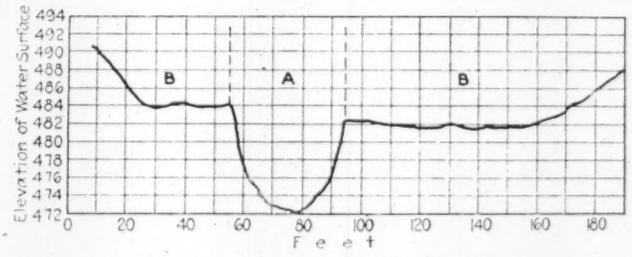



FIG. 3. TYPICAL CROSS-SECTION OF REACH (SEC. I)

puted (see "Weir Experiments, Coefficients, and Formulas," by Robert E. Horton, Water Supply Paper No. 200, U. S. G. S. for data on discharge coefficients of weirs and dams), and this will give the elevation of the water surface above the dam for any discharge. The water-surface elevation above the dam which is found for the given discharge is the elevation of the water at the foot of the first reach. The elevation of water at the location of the controlling section of the first reach is then assumed, and the corresponding value of $K_d$ taken from the $K_d$ curve. With this $K_d$ and the given discharge, $s$ is taken directly from the logarithmic discharge diagram. Multiplying $s$ by the distance from the foot of the reach to the controlling section gives the rise in water surface, and this added to the water-surface elevation at the foot of the reach gives the elevation at the section. If this elevation corresponds to the assumed elevation used in getting $K_d$, the assumption was correct, but if it does not, a second trial must be made, assuming a different elevation at the section and using the result of the first trial as a guide. When the computed elevation at the section coincides with the assumed elevation, the correct slope through the reach has been found. The fall through the reach is then computed, and this added to the elevation of water at the foot gives the elevation at the head of the reach. This is also the elevation of water surface at the foot of the reach above, and with it as a starting point the slope through Reach 2 is computed, using the same method as for Reach 1. In a similar manner, the computation is carried through the successive reaches as far as desired, or to the point where backwater becomes zero.

It may be stated in passing that the advantage of working through the slope calculations with only the

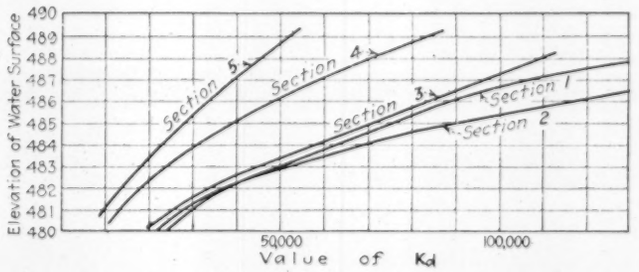



FIG. 4. CURVES SHOWING TYPICAL VALUES OF $K_d = CAr^{\frac{2}{3}}$

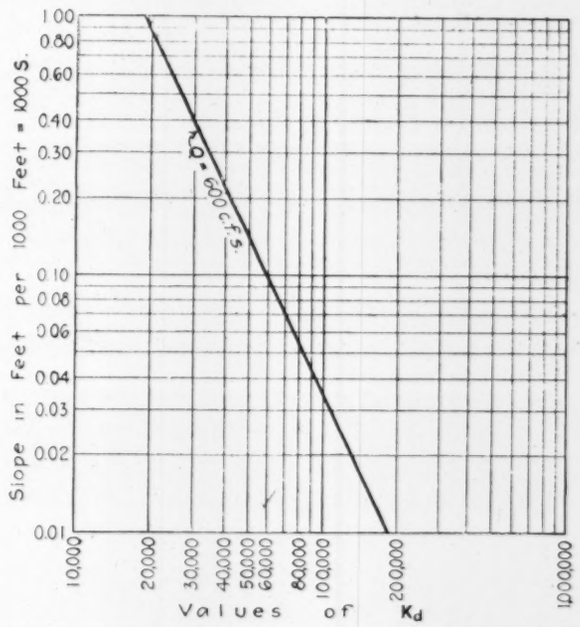



FIG. 5. DIAGRAM FOR THE SOLUTION OF $Q = K^p\sqrt{s}$

three quantities $Q$, $K_d$ and $s$, instead of the six factors involved in the usual method, more than compensates the slight additional labor required in computing the $K_d$ curves.

It will be noted that the coefficient of roughness has considerable effect on the results shown by the computations, and that it is therefore important that the value of this factor should be correctly determined. With a constant discharge, $s$ will vary as $n^2$, and a small variation in the value of $n$ will cause a relatively large variation in the required slope. If the slope is slight, a considerable change in its value may not produce any material change in the fall through the reach. As the slope increases, however, it becomes increasingly important that the roughness coefficient be correctly determined. Where it is possible, an actual profile of the water surface for a given discharge should be made,

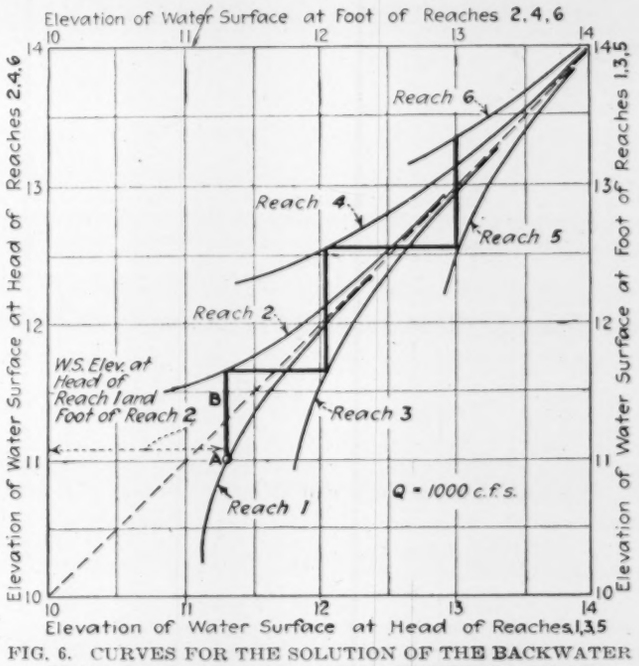



FIG. 6. CURVES FOR THE SOLUTION OF THE BACKWATER PROBLEM WHEN THE INITIAL WATER STAGE IS NOT DEFINITELY DETERMINED

TABLE I. METHOD USED IN TABULATING CROSS-SECTION DATA

| Elevation of Water Surface | Channel Section: Area of Section $A$ | Width of Water Surface $w$ | Mean Depth $d$ | Wetted Perimeter $p$ | Hydraulic Radius $r$ | $r^{\frac{2}{3}}$ | $K_d = \frac{1.49}{n} A r^{\frac{2}{3}}$, $n = .030$ | Overflow Section: Area of Section $A$ | Width of Water Surface $w$ | Hydraulic Radius $r$ | $r^{\frac{2}{3}}$ | $K_d$, $n = .040$ | Combined $K_d$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Section No. 1. | | | | | | | | | |
| 480 | 190 | 35 | 5 4 | 46 | 4 13 | 2 57 | 24,200 | | | | | | 24,200 |
| 482 | 264 | 38 | 7 0 | 52 | 5 08 | 2 95 | 38,500 | | | | | | 38,500 |
| 484 | 340 | 38 | 8 9 | 56 | 6 07 | 3 32 | 55,900 | 135 | 78 | 1 69 | 1 42 | 7,100 | 63,000 |
| 486 | 417 | 39 | 10 7 | 60 | 6 95 | 3 64 | 75,200 | 231 | 120 | 1 86 | 1 51 | 13,000 | 88,200 |
| 488 | 495 | 39 | 12 7 | 64 | 7 73 | 3 91 | 95,800 | 489 | 135 | 3 52 | 2 31 | 42,000 | 137,800 |

and this will give the data from which the roughness coefficient can be determined. Where this is not possible, it is advisable to investigate the effect of a change in the coefficient of roughness on the backwater profile. The assumption of too low a value for the roughness coefficient decreases the elevation of the water surface profile but increases the amount of back water, and vice versa. This is because the depth of water for a given discharge would be lower under normal channel conditions (no backwater) with the lower coefficient.

The case of the divided-flow problem offers the greatest opportunity for advantageous use of the $K_d$ curve. This problem arises when the cross-section is so irregular that the flow in adjacent parts of the channel must be considered separately. This is best illustrated in the case of a channel in which the water is above the banks, so that for accuracy the flow over the adjoining overflow lands must be considered separately from that in the channel proper. The elevation of water surface throughout the reach must be the same for both the overflow land and the channel, so that, ordinarily, the given discharge must be apportioned by trial between the two until this condition is satisfied. The use of the $K_d$ curve eliminates the necessity of proportioning by trial. The discharge capacity through the reach will depend directly on the total capacity of the two (or more) sections. Values of $K_d$ are computed separately for the channel and for the overflow land, and these are combined to form one $K_d$ curve for the entire cross-section which gives the total capacity of the entire cross-section at any depth. The slope calculation is then made in exactly the same manner as for a simple channel, using the $K_d$ curve for the combined sections. A typical backwater problem is illustrated by the channel shown in Fig. 2. This shows the reaches selected and the location of the cross-section controlling each reach, which will usually be at the middle of the reach. Fig. 3 gives one of these cross-sections and shows the manner in which the flow through the section is divided in order to allow for the irregularity of the section. A is the normal stream channel and B the overflow land. Table I gives a tabulation of the data and the results used in determining $K_d$ for this section, and Table II shows a convenient method of tabulating the slope calculations.

TABLE II. METHOD OF TABULATING BACKWATER COMPUTATIONS

| Number of Reach | Length of Reach | Elevation of Water Surface at Controlling Section | $K_d$ | $S$ Ft. per 1000 Ft. | Fall Through Reach | Elevation of Water Surface: Foot of Reach | Head of Reach |
|---|---|---|---|---|---|---|---|
| Discharge = 600 c.f.s. | | | | | | | |
| Elevation of water surface above spillway from discharge curve = 485.26 | | | | | | | |
| 1 | 400 ft. | 485.27 | 79,000 | 0.058 | 0.02 | | 485.29 |
| 2 | 800 ft. | 485.30 | 101,000 | 0.036 | 0.03 | 485.28 | 485.31 |
| 3 | 500 ft. | 485.32 | 75,000 | 0.064 | 0.03 | 485.31 | 485.34 |
| 4 | 400 ft. | 485.38 | 42,000 | 0.203 | 0.08 | 485.34 | 485.42 |
| 5 | 500 ft. | 485.52 | 31,000 | 0.375 | 0.19 | 485.42 | 485.61 |

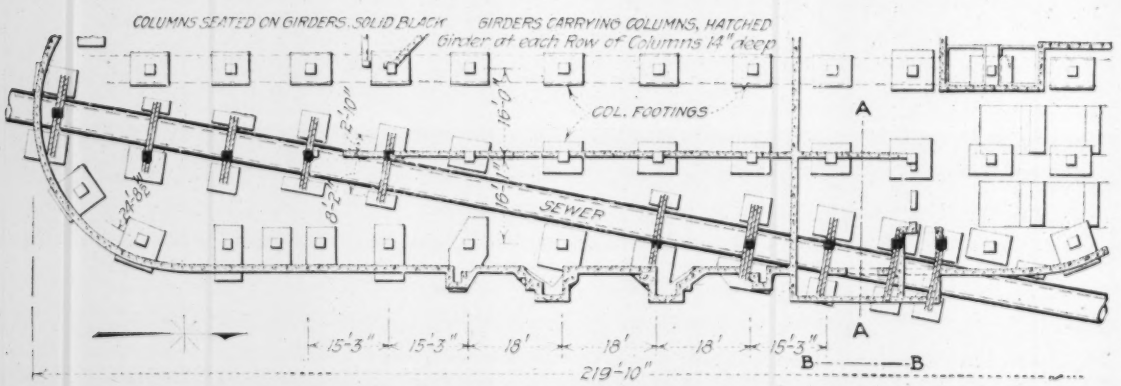
It may sometimes occur in backwater problems that the initial water-surface elevation at the lower end of the channel is unknown or not definitely established. Such a case might arise in the investigation of a proposed dam of undetermined height. It is obvious that for each assumed stage at this point, with a given discharge, there will be a different backwater profile. The writer has found the method shown in Table II very convenient in arriving at a complete solution of this problem.

# Sewer Complicates Foundation Plans

## Armory Building Has Concrete Columns Seated On Girders Spanning Sewer — Basement Floor Is Carried by Girders

UNSYMMETRICAL arrangement of the foundations of a Chicago armory was made necessary by the presence of a 4½-ft. brick sewer which crosses the site diagonally, as shown in the accompanying plan. The armory, built for the Second Illinois Cavalry, is a reinforced-concrete building, with pedestal footings on wood piles.

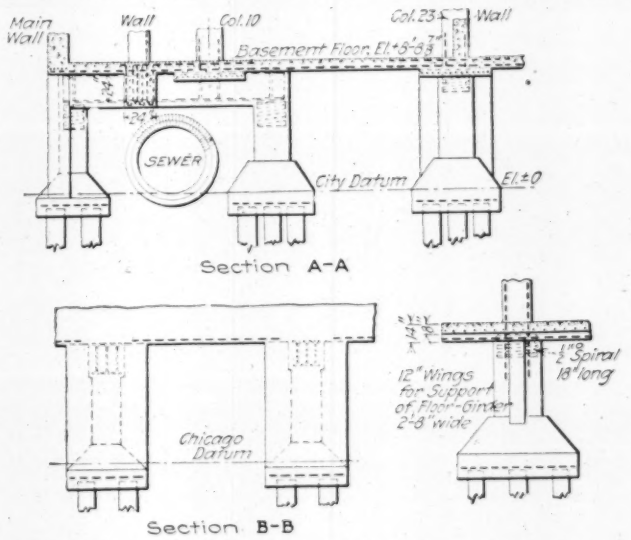
Where the sewer intersects column locations it is spanned by cross-girders which support the columns and are in turn carried by stub columns on footings on either side of the sewer. The girders are about 11 ft. long between centers of footings, and each is composed of three (in one case of four) I-beams of 18-in. to 24-in. size, the girder being cased in concrete as a protection against rust and corrosion. Where the sewer crosses the




SEWER UNDER ARMORY NECESSITATES UNSYMMETRICAL ARRANGEMENT OF FOOTINGS

line of the east side wall, this wall is carried on a continuous longitudinal girder extending between the cross-girders. The column loads on these cross-girders are from 130 to 165 tons. Typical construction is shown by the cross-sections.

Footings for the outer columns also support the 16-in. concrete wall of the basement, which is about 33 in. outside of the columns. This wall is irregular in plan, conforming to the circular or tower-shaped ends




SHORT COLUMNS CARRY CROSS-GIRDER FOR MAIN COLUMN AND LONGITUDINAL GIRDER FOR WALLS

of the building. Around the sewer and over the entire site the ground is filled to the level of the basement floor, but this fill does not carry the floor. An 8-in. slab covers the basement area, resting on the concrete footings and the cross-girders. Between the interior footings the thickness is increased to 14 in. for a width of about 4 ft., forming longitudinal girders which serve to brace the foundation and support the floor independently of the fill, as the armory is situated on ground reclaimed from the lake.

Column reinforcing consists of rods and spiral hooping, the rods being extended 4 ft. 3 in. into the footing or spliced to dowel rods 8½ ft. long, which are embedded in the footing. Spirals and dowels are omitted from the columns which rest on the I-beam girders. The floors above the basement are of slab-and-joist type, the joists being spaced 24 in. on centers and running longitudinally between the 12-in. transverse girders at the panel points. The depth of the joists is 10½ in., including the 2½-in. slab, upon which is a ¾-in. cement finish. Floor loads are 100 lb. for the basement and all floors.

This being a state building, the designs were made by J. B. Dibelka, state architect. Holabird & Roche, Chicago, as the consulting architects, prepared the plans. The general contract was let to the Hanson Brothers Co., for which C. T. McClelland was superintendent.

### Electric Street-Cleaning Vans Efficient

Recent reports state that electrically propelled street-cleaning vans used in England have proved much more efficient than horse-and-cart methods for collecting street refuse. One van accomplishes the same amount of work as three carts. The operation cost per day of three carts is $19.58, while that of one van is $8.70.

# Special Motor Equipment Used on Road Maintenance

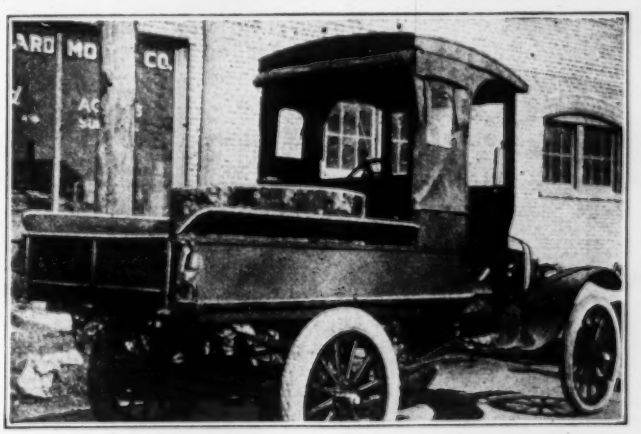
## North Carolina Highway Department Has Combination Truck and Tractor to Plow, Drag and Transport Materials and Men

By D. H. Winslow
State Maintenance Engineer, Raleigh, N. C.

MAINTENANCE is being succesfully handled in North Carolina by the use of specially constructed motor equipment. An interchangeable motor truck and tractor is employed and special maintenance autos are also being utilized by the district supervisor, who can thus cover a territory of from six to 14 counties. A new type of road drag is also being used.

With a view to keeping its large mileage of highways in good condition, the state has been divided into 10 districts, with a district maintenance supervisor placed in charge of each. A district consists of from six to 14 counties, and the supervisor has general supervision over all the patrolmen in his district, inspecting the roads and giving the patrolmen advice on maintenance methods. In order to cover this large territory, he is supplied with a specially constructed auto, as shown in an accompanying illustration. On account of the high prices for teams, labor and materials, the state has adopted new methods of maintenance. It was found that the patrolmen needed extra help under present conditions to cover their work, which consists of inspecting and dragging their roads after each rain, filling depressions with good material, removing débris from the right-of-way, repairing culverts, cutting weeds and brush at intersections to give a clear view, maintaining guard rails at culverts and bridges, and generally keeping the road in good condition. To give this extra help, the state has designed and had constructed special interchangeable motor trucks and tractors, which have been found of great assistance.

There are 100 counties in the state. Tractor trucks have been placed in 30 or more, and, on account of the satisfaction which they have given, are being placed in the others as fast as possible. A view of one of these

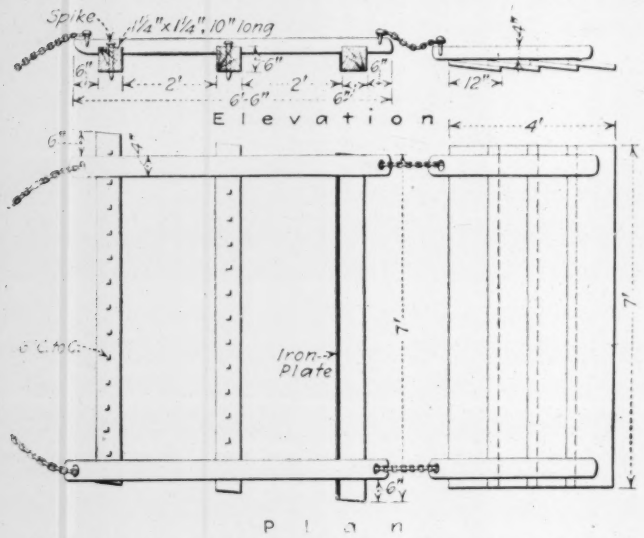


TRUCK WITH INTERCHANGEABLE WHEELS WORKS AS MAINTENANCE TRACTOR

trucks is shown in an illustration. Those in use at present have an ordinary small chassis with a truck body and a closed cab for the driver. The truck body is used to carry the special tractor wheels when moving from one section of road to another, and also to

carry such other equipment and men as are needed to do the work. Extra springs have been put over the rear wheels, so that a heavy load can be carried on the truck body. It is possible to change from a truck to a tractor in 15 minutes.

In some sections it had been necessary to move laborers 20 miles by mule teams, and then board the

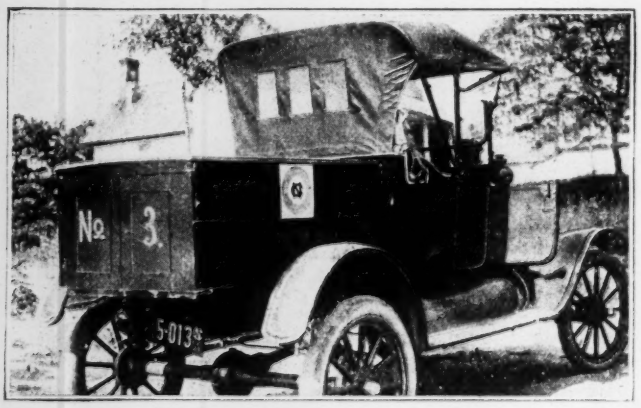



RURAL ROAD PLANER HARROWS, DRAGS AND PACKS

men in addition to paying them. By the use of the trucks they can return home each night, which is an advantage to all concerned. As the truck is equipped with a closed cab for the operator, he is able to work in the heat of the sun and cover a greater mileage in all kinds of weather. Formerly the teams had to abandon work during very hot weather.

When the machine is used as a tractor for plowing and dragging and for hauling road machines, a special hitch is employed, so that the tractor can stay in the middle of the road while the grader operates in the ditch. It is estimated that in plowing and dragging the tractor saves the hire of from six to eight mules, and that two men can do the work previously done by four.

The highway commission is trying out a new road planer in connection with its tractor-trucks. The new planer, the details of which are shown, increases the mileage dragged in a day and does better work than the old-style drag. It is modeled somewhat after the hone and is a combination of a harrow, a drag and a packer. The forward part has case-hardened spikes and




SPECIAL INSPECTION AUTO USED BY DISTRICT MAINTENANCE SUPERVISOR

loosens the bumps on the road. The middle section cuts and spreads this loosened material. The rear portion packs the material. Unlike a road grader, it cuts the high places and spans the low sections.

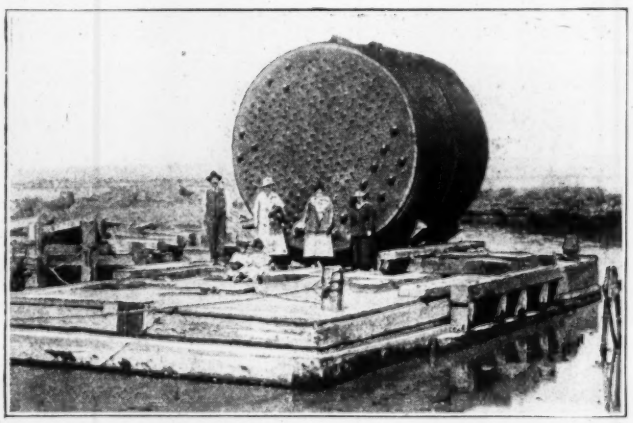
It has worked with marked success on earth, sand-clay, topsoil, gravel and on slightly worn macadam. The tractors have no difficulty in pulling it up almost any grade. By being made very light, it can be pulled with teams, but is designed for tractors or trucks.

Maintenance in North Carolina is carried on under the State Highway Commission; W. F. Fallis is state highway engineer, and the writer is in charge of the maintenance department.

## How 45-Ton Boilers Were Rolled 21 Miles Along Coast

### After Being Salvaged From Wreck, Donkey Engine Rolled Them, Between Tides and Storms, Along Improvised Roadway

MACHINERY and other equipment salvaged from the wrecked passenger steamer "Bear" was recently removed from the vessel as it lay stranded in the surf on the northern California coast. Salvaging the boilers presented a special problem, because of the bulk and weight of each piece. After the boilers had been taken out and landed on the beach, efforts were



LOADING BOILER ON BARGE AT MOUTH OF EEL RIVER

made at frequent intervals, extending over almost a year, to salvage them by towing them to sea. This plan was then abandoned, and a contracting firm undertook to deliver them at a wharf in Eureka, Cal., for a fixed sum. The boilers were successfully moved by rolling along 21 miles of ocean beach and rocky coast, making two river crossings, and finally loading them on a barge on Humboldt Bay for the last lap of the journey.

A donkey engine and other necessary equipment were landed on the beach near the boilers after they had been brought ashore, and a rough roadway was built on which to roll them. For the most part the roadwork consisted of breaking up large rocks with dynamite, but there were also several deep cuts which had to be made in solid rock. Part of the way work could be carried on only during calm weather and at low tide, because at high tide the surf broke against the cliffs. Progress was frequently delayed because a rough sea would wash out the roadway prepared for the moving operations.

PASSING THROUGH ROCK CUT IN BASE OF CLIFF

The boilers weighed 45 tons each and measured 12 ft. in length by 13 ft. 8 in. in diameter. They were rolled along one at a time by means of a single ¾-in. line from the engine drum. The end of the line was attached to the front of the engine frame and was laid thence along the ground, the bight being passed around the boiler and back to the engine drum. This method gave a direct pull on the boilers, and if roadway conditions had been favorable they could have been moved ahead at a rapid rate.

One of the chief problems was to keep the boilers rolling straight. With a diameter greater than the length, there was a tendency to "head off," first in one direction and then in another. This was overcome by attaching a block to a line on the ground just ahead of the boiler and pulling over the bight of the line with a team of horses. The block was attached to the line far enough ahead of the boiler so that the pull could be made and the block loosened before the boiler reached it. Thus, the tendency to roll off to one side could usually be corrected without stopping the engine. After the line had been moved sufficiently the block would be loosened and allowed to slip along the line as the team walked ahead, until it was necessary to pull to one side again.

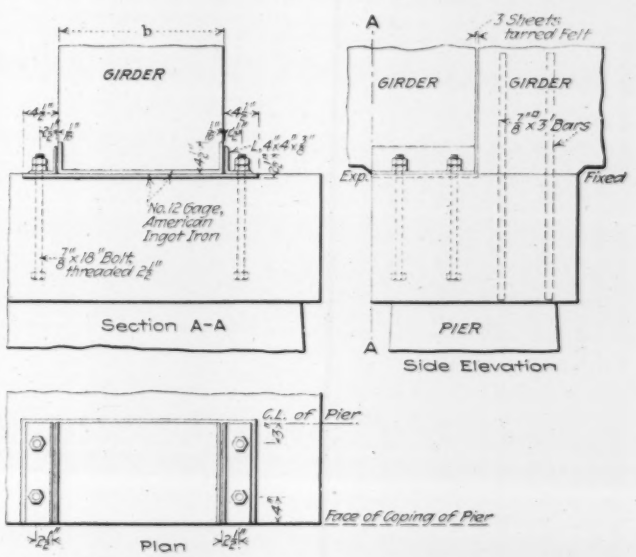
In this manner the boilers were sometimes moved an entire quarter of a mile without having to stop the engine. The donkey engine was usually set about a quarter of a mile ahead of the six boilers and they were rolled along one at a time until all had been brought up, whereupon the engine would be moved again.

In crossing the Bear River a ford was found where the boilers could be rolled across by the same method that was used along the beach. At the Eel River, however, this plan was not feasible, and there the boilers were loaded on a barge one at a time and towed for two miles t a favorable point for continuing the rolling process. On arriving at the shore of Humboldt Bay all six were loaded on a single large barge and towed to the wharf in Eureka. The contract was taken by the Mercer-Fraser Co., of Eureka, Calif., J. D. Fraser, president, and J. L. Brown, secretary.

## New Type of Expansion Joint Devised for Concrete Girders

FOR a bridge just designed for the Highway Department of the State of Arizona, S. M. Cotten of the office of the state engineer has devised a new type of expansion joint, illustrated in the accompanying drawing. The joint has points of novelty and desirability for reinforced-concrete girder bridges. It consists, in effect, of a bent iron plate, in which the concrete girder is seated, which slides on a flat plate fastened to the pier, sidewise movement being avoided by guide angles also fastened to the bed plate.

The principal features of the design are ease of fabrication and low cost, according to the claims made. American Ingot Iron is specified for the plate because of the rust-resisting quality of this metal, this being a factor of most importance in the sliding expansion joint. The upper plate is not anchored to the girder in any manner. Mr. Cotten explains this feature as follows: The purpose of the expansion joint is to permit the movement of the structure with the minimum of friction. The coefficient of friction of concrete on steel




EXPANSION JOINT FOR CONCRETE GIRDER CONSISTS OF TROUGH-SHAPED STEEL PLATE SLIDING ON BEDPLATE

is much greater than that of steel on steel. Should these plates rust or for any reason develop a greater coefficient of friction between their contact surfaces then that of concrete on steel plus a certain amount of bond, the girder will move on the upper plate.

### Motor Truck Used To Inspect Water-Supplies

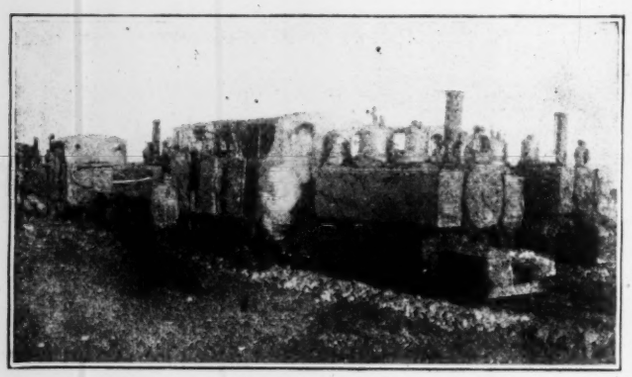
Public water-supply field investigations made by the engineering division of the New York State Board of Health have been materially increased in number during the past season, largely by the increased facilities afforded by the use of a small motor truck. In every case they include a careful inspection of the watershed and of the conditions affecting the water-supply, and the collection of samples. The new method of transportation makes possible a much more extensive and complex sanitary control than existed heretofore.

# Dwarf Railways of the Front Line Trenches

## The Soixante or 60-Centimeter-Gage Tracks Used For Many Purposes—Connect With Broad-Gage Railroads In Battle Areas

By James E. Sellers
Private, 23rd Engineers, American Expeditionary Forces, France

MOST effective of the "combat railways" which served the front-line trenches in the great war was the French narrow-gage *Voie de Soixante*, generally called the Soixante railway, the gage being 60 cm., or 1 ft. 11⅝ in. Various types of locomotives and cars were used, and their work in the battle areas of France was of exceptional variety. The Soixante railway was used chiefly for the transportation of troops, taking the wounded from the front to hospitals in the rear, carrying to the front rations, ammunition, guns, fuel, clothing supplies, forage, water, engineering supplies, etc. The materials were received on the broad-gage track at the "railhead" and transferred to the narrow-gage cars. Some of the materials were received by canal barges.



AMERICAN NARROW-GAGE LOCOMOTIVE IN YARD

According to the nature of the work and the proximity to the trenches, the means of transportation varied from mules and horses to the American (Baldwin) locomotives, the French double-end steam locomotives, and gas engines. It was not an uncommon sight to see three of these little "dinkies" chugging and puffing with their load of 28 cars over a grade of three per cent. The steam locomotives were used up to within 5000 yd. of the front trenches. Gas engine, horse, or man-power was used from this point to the destination, because the enemy was able to detect all movements of steam locomotives. A steam locomotive within a distance of three miles from the front, without careful camouflaging of its surroundings, would be "shot up" in 10 minutes.

### Locomotives and Power

Locomotives used on the Soixante differ in size and design. The American steam locomotive, 2-6-2, is a 50-hp. engine with a wheel-drive base of 5 ft. 10 in.; total wheelbase 15 ft. 7 in.; overall length 21 ft. 7 in.; width 6 ft. 5 in.; height above the rail, 9 ft. 3 in., and weight 34,500 lb. The A. E. F. gas engine is equipped with a four-cylinder, four-cycle, 35-hp. water-cooled motor, wheelbase 3 ft.; overall length 10 ft. 9 in.; width 4 ft. 7½ in.; height 7 ft. 11 in., and weight 8000 lb. The French double-end steam locomotive (Model 1888) has a total wheelbase of 12½ ft.; total length about 18 ft. 9 in.; width 5 ft. 2 in.; height 9 ft. 5 in., and weight about 31,000 pounds.

Four kinds of cars were used: Box cars with a capacity of 600 cu.ft., or 22,000 lb., weighing 10,900 lb., with a length of about 24 ft., width of 6 ft. and height of 8 ft. 4 in.; gondola cars with a capacity of 210 cu.ft., or 22,000 lb., weight 9000 lb., length 24 ft., width 5 ft. 7 in., height 4½ ft.; flat-cars with a capacity of 22,000 lb., weight 8000 lb., length 24 ft., width 5 ft. 7 in., height to the floor 2 ft. 4 in.; dump cars with a capacity of 27 cu.ft., weight 1050 lb., length 5 ft. 8 in., width 4 ft. 8 in. Tank cars, used for carrying water to the front-line trenches, were about the same design as the box car, with the exception of the tank, and weighed 12,200 lb. The French used generally a gondola car with a capacity of about 10 tons.

All buildings were made from standard designs when possible, calling for wood and corrugated-iron construction, except within the front area, where all buildings are in dugouts. It is not unusual to see a cluster of these dugouts, emerging from a cut or hillside, resembling a huge culvert, partially filled with drifting sands. From above and in front they are carefully camouflaged to resemble natural earth, and it is hard to detect them from a distance of 2000 yd., or more.

The narrow-gage railways generally run at right angles to the broad-gage line at the railhead, their main lines being connected with laterals in loop formation to form a continuous one-way road. Double tracking is only used when short hauls call for it. In this case, ample protection must be afforded to the operation of the line.

The single continuous track construction allows the handling of more traffic in a shorter time, and also tends to serve more area and allows for the diversion of traffic over any lateral when necessity demands. The average train run is about 10 miles.

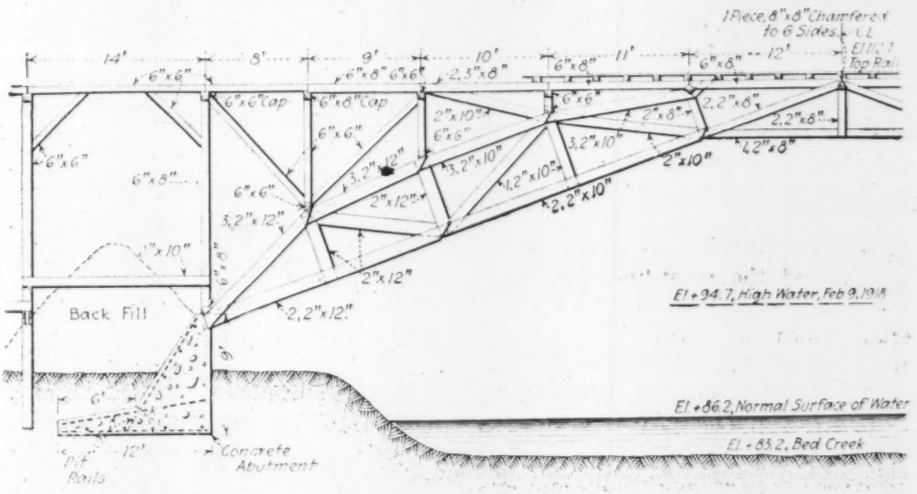
### Construction of the Railway

In the construction of the Soixante system it is very important that no grades should exceed three per cent., and curves should not be sharper than 50 m. (164.04 ft.) in radius. In the St. Mihiel salient the writer has traveled lines having 5% grade and 30-meter (98.42-ft.) curves, but this was unusual and would not have occurred if the topography had not made it necessary in order to traverse the territory without detection by the enemy. Compensation for curvature on grades is made at the rate of 0.02% per degree.

It is very difficult to determine accurately the cost of constructing this railway, as the data are kept by the Government. The British assume that one mile of track completely laid requires 7000 man-power hours; the French are capable of grading, tracklaying and ballasting about 0.75 m. (2.46 ft.) of roadway per man per day.

The track sections are composed of two 25-lb. rails, 5 m. (16 ft. 5 in.) in length, bolted to eight steel ties, and weighing about 25 lb. per yard. These sections are very easily handled and placed by four men. The British and French sections are similar in design, but,

instead of bolting the rail to the ties the French rivet them; the British use wooden ties in most cases in connection with steel ties, and this is also done on American lines when soft ground or muddy places are encountered. To illustrate the accomplishment of these narrow-gage railways—it is not uncommon to unload an entire trainload of supplies in 30 min. and place them in piles ready for distribution. For example, 308 tons of material have been received at 9 a.m., some five miles from the front, and in less than three hours' time placed in the hands of the cooks at the front ready to be made into "chow."




DESIGNED IN ACCORDANCE WITH LUTEN FORMULA FOR CONCRETE ARCH

The Soixante was responsible in a great measure for the wonderful progress made by the Americans during the trying days of September, when they pushed the Huns out of the St. Mihiel sector. The many uses found for the narrow-gage railway during the past four years prove conclusively its value in military tactics.

# Timber Arch Bridge One Hundred Feet in Length

## Forces of Fulton Coal Company Design and Build Structure—Luten Formula for a Concrete Arch Ring Used

BY D. R. WALKINSHAW
Greensburg, Penn.

A TIMBER arch span 100 ft. long was built recently over the Big Sewickley Creek at Hunker, Westmoreland County, Penn., for the purpose of getting out coal during the shortage. The bridge was designed by the writer for the Fulton Coal Co. and was erected by the forces of the company under the direction of the carpenter.

The increased demand for coal has caused the development of a large area of "Freeport" coal in the district around Hunker, which coal has hitherto been considered of little value. In a distance of five miles along the above-named creek some forty mines have been opened in the "Freeport" vein.

In order to provide the shipping facilities that were needed it has frequently been necessary to extend trestles or tipples across this creek so as to load the coal at the railroad sidings, and the accompanying sketch shows the design of one of these bridges with the various dimensions.

Big Sewickley Creek has considerable width at places, and the bridge shown was designed with a clear span of 100 ft. and a height of about 18 ft. The arched members were designed in accordance with the Luten formula for a concrete arch ring. The curve is therefore a mean between the semicircle and the ellipse. The bottom chords and trusses are merely used to stiffen the short panels. The bridge is symmetrical throughout and consists of two ribs spaced 4½ ft. c. to c. and completely X-braced. In order to prevent swaying at the center two ½-in. wire-rope guys were anchored to large trees along the bank. A photograph of the completed bridge, in which is seen the old suspension footbridge heretofore used for crossing the stream, is shown.

The writer was the designing engineer and Joseph Kettering was the carpenter who had charge of the construction for the coal company.

TIMBER ARCH CONNECTS COAL MINE WITH RAILROAD SIDING

# Field Methods on Rapid Stadia Surveys at Columbus

## All Lines Run by Stadia, Levels Taken With Transit—Special Rod Extension—Colored Cloths and Whistles for Signals

BY H. K. KISTLER

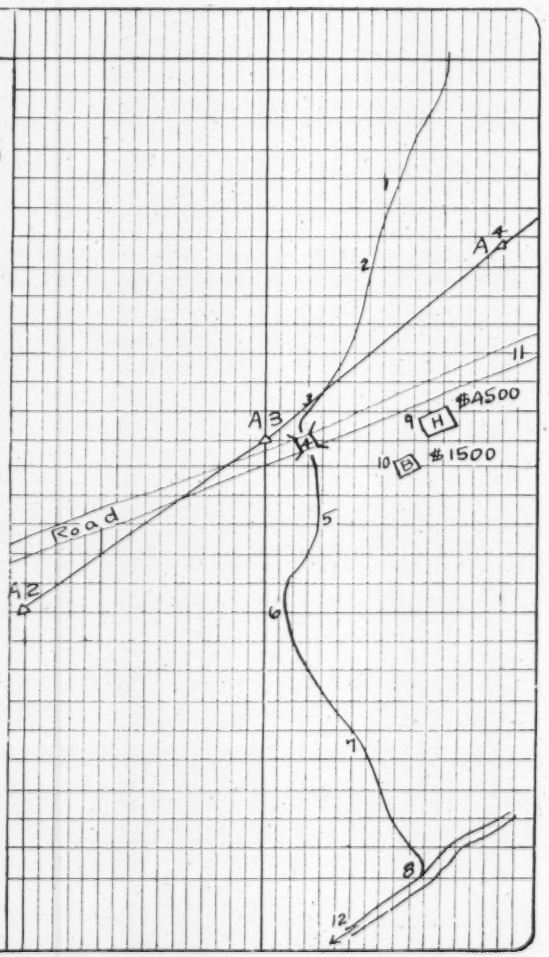
Instructor in Civil Engineering, Pennsylvania State College

COSTS and progress of the stadia surveys made for the Franklin County Conservancy District, Columbus, Ohio, were outlined by L. R. Howson in *Engineering News-Record* of Sept. 27, 1917, p. 606. A description of some of the details of the actual field work, as carried out by one of the parties, may be of interest. At the time the surveys were made the writer was assistant engineer for Alvord & Burdick and in charge of the field party making the survey of the Delaware reservoir area.

Primary transverse lines were run by stadia, the double-deflection method of measuring angles being used. Stadia distances were read in both directions on each line, the mean of the two readings being taken, or the checked-back reading in each case of apparent error in the forward reading. Levels were carried by transit. One tripod leg was graduated to indicate the height of the instrument above the hub when the point of the plumb bob was swung over to that leg. Level readings were taken in both directions on each line, and the difference of elevation was computed in both directions for each line, the mean of these differences of elevation being adopted. Where level readings could not be taken, the upper or lower cross-hair was read and the half interval applied. Vertical angles were seldom necessary on the primary line. Frequent level checks were had at United States Geological Survey bench marks. Primary traverses averaging 15 miles in length were easily kept within an error in minutes of angles of one-half the length of traverse in miles and within a linear closure of 1 in 1500, while levels always checked between Geological Survey bench marks as well as five-hundredths of the length of the levels in miles.

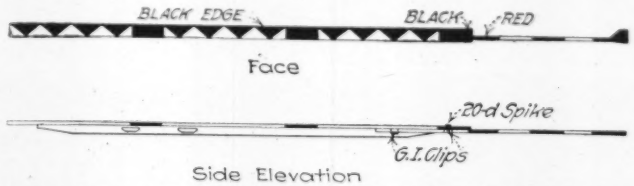
The transitman was provided with a referee's whistle, for signalling to the rodman. Each rodman carried a strip each of red, white and blue signal cloth. The red cloth tied in a single simple knot near the top of the rod indicated the bottom of a ditch, creek or ravine watercourse; the white cloth similarly placed meant a river bank or a road center line; the blue indicated a fence-line intersection; the hat held in the hand and waved or placed on top of the board meant the corner of a building. These signals were necessary, because one cannot call shots half a mile, and it is impossible to tell at that distance whether the rodman is at the corner of a building or 100 or 200 ft. nearer on line with it.

| Sta. | Shot | Az. | Dist. | Rod | Chg. | Elev. |
|---|---|---|---|---|---|---|
| A3 | HI=4.96 | LHI=975.2 | | | +3.69 | 970.27 |
| | A2 | 44-26 | 520 | 8.62 | -3.66 | |
| | A4 | 225-20 | 462 | 3.27 | +1.69 | |
| | dh 1 | 205 — | 450 | 4.3 | | 970.9 |
| | | 165-30 | 500 | 3.2 | | 972.0 |
| | dh 2 | 215-30 | 300 | 4.7 | | 970.5 |
| | dh 3 | 261-45 | 80 | 5.3 | | 969.9 |
| | br 4 | 330-20 | 108 | 2.7 | | 972.5 |
| | dh 5 | 337-30 | 215 | 5.9 | | 969.3 |
| | dh 6 | 1-20 | 305 | 6.6 | | 968.6 |
| | | 7-30 | 455 | 4.8 | | 970.4 |
| | dh 7 | 332— | 470 | 7.3 | | 967.9 |
| | dh 8 | 320-10 | 610 | 8.0 | | 967.2 |
| | H 9 | 300-20 | 210 | 2.8 | | 972.4 |
| | B 10 | 325-30 | 225 | 3.1 | | 972.1 |
| | | 327 — | 510 | 4.7 | | 970.5 |
| | ℄ Rd 11 | 266-20 | 400 | 3.5 | | 971.7 |
| | | 180 — | 800 | Th 2.5 −1.5 | | 976.7 |
| | | 176-20 | 1010 | Th 2.3 − 2.7 | | 977.9 |
| | | 181-30 | 1420 | Th 2.7 −4.4 | | 979.6 |
| | dh 12 | 334 — | 865 | 10.2 | | 965.0 |
| | | 183-20 | 1680 | +0°-21′ | +10.3 | 980.6 |
| A4 | HI=4.96 | LHI=976.9 | | | +1.67 | 971.94 |
| | A3 | 45-20 | 465 | 6.57 | -1.65 | |
| | A5 | 227-19 | 1015 | 2.79 | +2.13 | |
| | | 180-20 | 800 | 2.3 | | 974.6 |
| | | 179 — | 520 | 3.7 | | 973.2 |
| | | 177-30 | 305 | 4.2 | | 972.7 |
| | | 330 — | 155 | 6.3 | | 970.6 |
| | | 271 — | 210 | 5.1 | | 971.8 |




REPRODUCTION OF FACING PAGES TAKEN FROM NOTEBOOK—LOOSE-LEAF PAGES USED

In shots taken on the rod the following order was observed: Distance and level readings were taken and *remembered;* the rodman was signalled to move to a new point (one blast on whistle for Rodman No. 1 and two blasts for Rodman No. 2); the level reading and distance recorded and the azimuth read and recorded before the instrument was disturbed. If the level reading was taken the distance had been read on a




FIFTEEN-FOOT STADIA BOARD WITH EXTENSION

shot it would be taken first on the next shot, thus saving the time necessary to reset the bubble. Three blasts on the whistle indicated that Rodman No. 1 could not be seen and four blasts that Rodman No. 2 was not visible.

Inclement weather caused practically no loss of time. Each rodman was provided with a rainproof coat. A large wagon umbrella which had been treated with a coat of boiled linseed oil was used to protect the transit and the transitman during rain or snow. The umbrella was mounted on a sharpened oak post driven into the ground near the station and was carried between stations by the rodman giving backsight.

A system of rectangular coördinates was established for the area to be surveyed, and primary traverses were computed and adjusted before the plotting of topography was started. Secondary or topography lines were computed by slide rule. Having the coördinates of the primary stations previously established greatly simplified the work of adjusting and plotting the secondary lines.

A sketch, showing the station occupied, the back station and the forward station, was required for each topography point used; the top of the page being always oriented to the north. The form of notes kept is illustrated by the accompanying facing pages reproduced from the notebook.

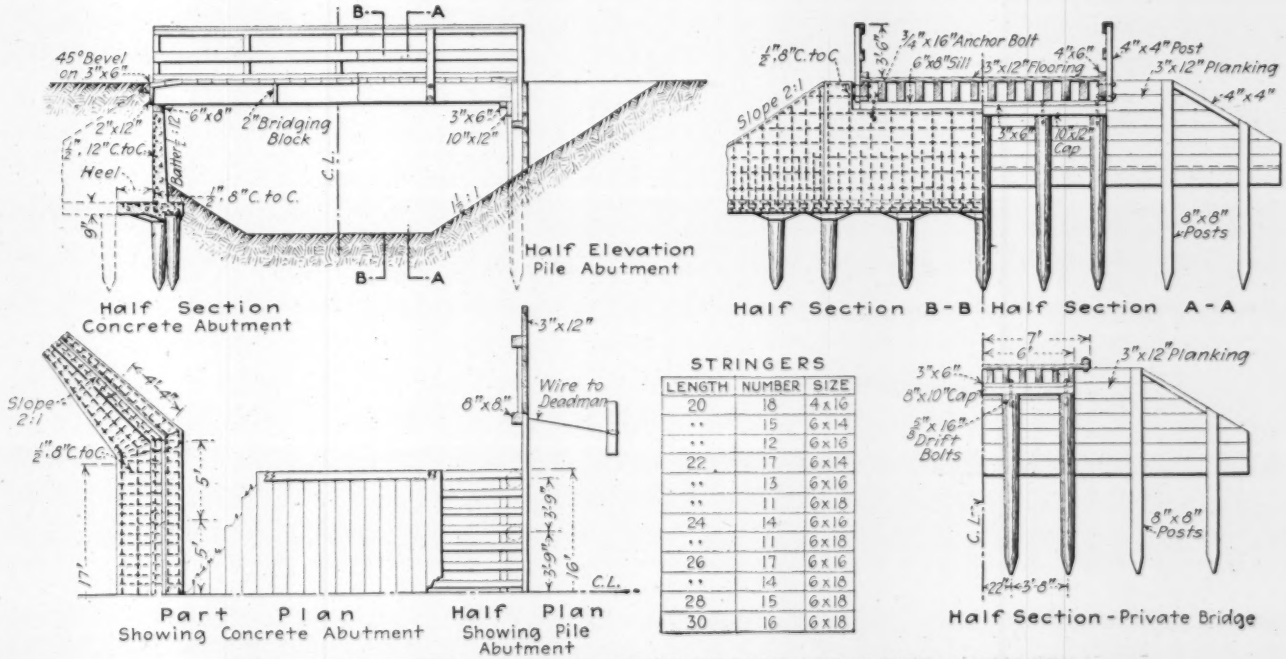
# Standard Bridge Abutments on Canal Projects

## Two Types of Abutments, Reinforced-Concrete and Timber Pile, Are Used on Rio Grande Irrigation Development

By D. C. Willett
El Paso, Texas

One of the most serious problems in the Rio Grande project in New Mexico and Texas has been the construction of satisfactory foundation in the quicksand which underlies the surface soil throughout the region. On all main highways of the Reclamation Service, substantial timber bridges are being installed, usually with reinforced-concrete abutments of the type illustrated herewith, instead of the heavier gravity type of plain concrete walls. In this soil, piling is necessary, the piles being easily jetted into place.

The reinforced-concrete abutments, one of which (on the Borderland Road at Nemexas drain in the Mesilla valley) is illustrated here, are designed to have a base width of 70% of the height. The heel for a 6-ft. height is 2 ft. 4 in., and for each foot of height added or subtracted 4 in. are added or subtracted for the base. The wing wall is made at an angle of 45°, the length depending upon height and local conditions, the top generally having a slope of 2:1. Reinforcement is used as noted on the drawing, but for higher and lower walls the steel is spaced according to the United States Reclamation




DETAILS OF THE TWO TYPES OF ABUTMENT USED FOR HIGHWAY BRIDGES

CONSTRUCTION OF REINFORCED-CONCRETE ABUTMENT

Service standards. The length of the pile below the concrete is varied to suit conditions, but the minimum is 5 feet.

The pile abutments are designed as shown; in the case of quicksand extra sheeting is carried down to several feet below the surface of the slope. The length of piles varies with soil conditions encountered, but the minimum is 12 feet.

The work shown in the photograph was done by the Government force, with L. R. Fiock as superintendent.

## Algae Cause Taste in Fort Worth Water

By Robert H. Craig

Captain, Sanitary Corps, United States Army, Camp Sanitary Engineer, Camp Bowie, Texas

ALGÆ growths give the water-supply of Fort Worth so much vegetable taste in the summer and autumn months as to necessitate special treatment. Copper sulphate having proved to be inadequate an aëration basin is being built.

The water-supply is drawn from Lake Worth, an artificial reservoir formed by damming the west fork of the Trinity River. The lake has a capacity of 35,000,000,000 to 40,000,000,000 gal., an area of nine square miles and a drainage area of 1800 square miles.

Samples of water collected in November, from within a radius of a half mile of the water intake, showed the following microscopic organisms:

| | |
|---|---|
| Diatomaceæ | *Navicula* |
| Chlorophyceæ | *Spirogyra*, *Pandorina*, *Hyalotheca*, *Closterium* |
| Cyanophyceæ | *Gloeocapsa* |
| Protozoa | *Arcella*, *Paramaecium* |
| Crustacea | *Diaptomus*, *Cyclops* |

Tumblerfuls of water collected from the top of the filters at times showed hundreds of crustacea.

The water from the lake flows six miles through a concrete pipe line six miles to the filtration plant. Iron and lime is used as a coagulent and liquid chlorine as a disinfectant.

After filtration the water often has a stronger taste than the raw water, giving rise to the belief that filtration breaks up the minute particles of the algæ and causes the vegetable oils to be diffused through the filtered water. The taste in the system is the same as the taste in the lake, showing that the application of chlorine does not make any alteration in the kind of taste.

It was the intention of the municipal authorities to clear the bed of the lake of trees and underbrush but not to strip the land, as the cost would have run into prohibitive expense. Some of the trees were removed, but difficulty was experienced with the contractors, and the lake was filled up without stripping and with little clearing.

Thousands of trees were covered with the water, and many are partly submerged and partly exposed. The theory was advanced by some that the taste was due to vegetable decay of the trees, forming such products as tannic acid, but as the taste disappears after the autumn "turnover" it would seem that the taste is entirely due to algæ. This belief is strengthened by the fact that handfuls of the algæ growths have an odor which corresponds to the taste noticeable in the water.

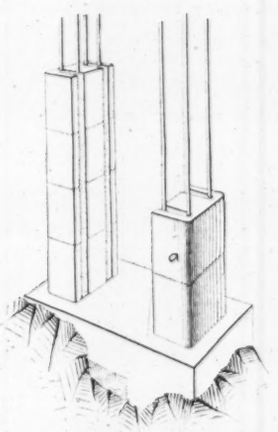
Attempts were made to rid the water of the taste by dragging bags filled with copper sulphate through the water from the rear of a motor boat, within a radius of three-quarters of a mile from the water intake. The "draw-off" level at the intake was also changed. These measures helped somewhat, but did not eliminate the taste.

An aëration basin is being constructed at the filter plant, designed by John Gregory, consulting engineer, Baltimore, Md. It is a shallow basin with 64 aëration nozzles spraying the water into it. The aëration will undoubtedly better the condition, and it is hoped will get rid of the taste entirely.

## Reinforced-Concrete Columns of Precast Pieces

PRECAST concrete pieces of similar size and shape to the usual concrete block have been used in France recently to build up reinforced-concrete members, notably columns.

A typical detail of a column is illustrated herewith in the accompanying sketch. Each of the concrete pieces as shown is about 10 in. high and weighs about 20 lb., so it can be lifted into place by hand. In operation, a concrete base is poured in place and rods are left protruding from the base in such location as to form a reinforcement for the column. The E-shaped blocks with their two grooves to surround the reinforcement are then slipped into place, and the column is built up with mortar joints. After it has reached the proper height the grooves into which the rods slip are filled with poured concrete. A number of details have been devised for column connections and for various types of construction. The method is described in a recent issue of *Le Génie Civil*.



PRECAST CONCRETE COLUMNS

# ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

## "Engineering News" Book Index Completed

INDEX TO "ENGINEERING NEWS" FOR THE YEARS 1919 TO 1917 INCLUSIVE—Compiled by Nathan C. Rockwood, Assoc. Am. Soc. C. E., Formerly Associate Editor of *Engineering News*. New York: McGraw-Hill Co. Cloth; 6 x 9 in.; pp. 469. $3 net or $6 in combination with indexes for 1890-99, 1900-04 and 1905-09.

The publication of this volume completes the series of uniform consolidated indexes to *Engineering News* from 1890 to the close of March, 1917. The four volumes in the series are as many keys or guides to the history of civil engineering and construction for the 17 years preceding our entrance into the great war. The three earlier volumes, all fortunately still in print, covered the periods 1890-99, 1900-04 and 1905-09.

In the preface to the 1905-09 index it was stated: "This book is not 'an enterprise of profit' . . . it is published solely for 'the convenience of the users of *Engineering News*.'" The same is true of the present volume. It is designed to make easily and quickly accessible the contents of thousands of pages of *Engineering News*, from 1910 to its consolidation with *Engineering Record*.

Like the earlier volumes, the fourth is a carefully classified subject index, with liberal use of cross-references. The author had the advantage of intimate knowledge of the contents of *Engineering News* during the period covered, a knowledge acquired by service both on its editorial staff and as indexer of its half-yearly volumes. The general plan of the earlier indexes, made by a trained indexer under the guidance of the editors, has been followed by Mr. Rockwood, because long use has proved its value and also to make the whole series uniform in style, so all four may be used together with ease.

An idea of the wealth of material on leading topics made more quickly available by the 1900-17 index may be given by noting that Bridges, with its subclassifications, fills 22 pages; Buildings, nine; Canals, seven; Concrete, 15; Dams, nine; Engineers, eight; Railways, 26, not counting six pages on electric railways and electrification of steam railways; Roads, 19, besides three pages on Highways; Sewage Disposal and Treatment, nine; Surveying, nine; Tunnels, six, not counting three pages on Subways; Water Purification, seven; Water-Supply and Water-Works, 12.

The wide range of topics and a further idea of the large number of references included are indicated by the fact that aside from the 12 heads already mentioned as filling six to 26 pages each there are 35 or more that fill at least two pages. These heads are: Aqueducts, Arches, Cement, City Planning, Columns, Contracting, Drawing, Engineering and closely related matters, Engineering Schools, Flood Protection and Floods, Foundations, Garbage, Irrigation, Locomotives, Motor Trucks, Municipal, Patents, Piles, Pipe, Pumps, Rails, Reservoirs, Retaining Walls, Rivers, Sewerage, Ships, Steel, Subways, Tanks and Standpipes, Typhoid, Valuations, Viaducts, Water Power, Wharves and Docks.

Thoroughness is evidenced by not only the cross- references already mentioned but also by the inclusion of news notes of permanent value. To save the reader from being mislead, the notes are designated by the letter "n." As a further guide to be found under the separate entries the approximate number of words in each article of 500 or more words in length is given. Editorial discussion and letters to the editor are designated by abbreviations in parentheses.

Before concluding, it may be noted that an index to the first 17 years of *Engineering News*, 1874-90, was published in 1891 as a thin volume of 118 pages. It has long been out of print. Moreover, having been made before the days of trained indexers, this early volume is not satisfactory. Fortunately, the later and more important part of the period is covered by the valuable "Descriptive Index of Current Engineering Literature, 1884-1891," prepared under the direction of the late Prof. J. B. Johnson for the Association of Engineering Societies, and since continued as "The Engineering Index."

Finally, it is a pleasure to announce that it is the intention of *Engineering News-Record* to publish consolidated indexes to its contents at five-year intervals, thus carrying on without a break the work of making readily available the record of engineering practice and progress pursued for so many years by *Engineering News*. This, the editors feel confident, will encourage subscribers to preserve and bind their volumes, a practice which already prevails to a large extent but might well be extended with advantage.

## Asphalts Broadly Treated

REVIEWED BY A. W. DOW
Consulting Paving Engineer, New York City

ASPHALTS AND ALLIED SUBSTANCES: Their Occurrence, Modes of Production, Uses in the Arts, and Methods of Testing—By Herbert Abraham, B.S. of Chemistry, Member A.C.S., S.C.I., A.S.T.M., I.A.T.M. New York: D. Van Nostrand Co. Cloth; 6 x 9 in.; pp. 606; illustrated. $5

There is hardly a subject with which the engineering profession has to deal that is more difficult to inform oneself on than the technology of asphalts and allied materials. What little has been written on this subject is scattered through numerous magazines, proceedings of societies and Government publications, many of which are out of print or inaccessible to the large majority. Mr. Abraham has gone far to remedy this difficulty by abstracting the literature on this subject and compiling it with considerable information from well known authorities and original data of his own.

The book is divided into five parts. In the first is a short history of the early discovery and uses of bituminous materials, and the classification, terminology, chemistry and geology of bituminous substances. The terminology and classification appear to be entirely original with the author, as is usually the case in all books published on this subject. Part II deals with semi-solid and solid native bituminous materials, their occurrence and methods of refining. Under this heading are classed such materials as ozokerite and other mineral waxes, pure native asphalts and those associated

with more or less mineral matter, gilsonite, grahamite and allied materials, elaterite, wurtzilite, albertite and bituminous shales. The third part takes up tars and pitches and their production from wood, peat lignite, bituminous shale, fatty acid and bone tar. It also deals with petroleum, its refining, and products made therefrom, such as all grades of burning oil, paraffine wax, wax tailings, residual oils, asphalt both straight run and blown, and pitches formed as byproducts in the manufacture of various petroleum products. The fourth part treats manufactured products from the various pitches and bitumens, and their application and uses in the arts, such as paving, waterproofing, roofing and paints. The fifth part deals exclusively with the methods of testing bituminous materials.

The book is comprehensively written, and the subjects are succinctly described and well illustrated by photograps and diagrams. As the work covers a very large field, many of the topics are of necessity greatly condensed, but the author has given preference to those topics concerning which little has been published, such as fatty-acid pitches; bituminized roofings, floorings and other fabrics; bituminous paints, cements, varnishes and japans.

As is to be expected in a book covering so large a field, there are a number of misstatements in various sections. These, in the majority of cases, are of minor importance and do not detract from the value of the work. There are, however, a few that should be commented on, as, for instance, in speaking of the steam distallation of oils for the production of asphalt, the maximum temperatures stated as those to which the stills are heated are entirely too low. Excellent California asphalts are often made at temperatures much over 700° F. It is also the custom in the production of high-grade asphalts from Mexican petroleum by steam distillation to carry the temperature considerably over the maximum stated by the author, and it is doubtful whether a practical run could be made at so low a temperature.

The description of the different grades of California asphalt under the designations A, B, C, D and E are very misleading. In the first place, the limits of the penetration of the different grades are not those usually in use, although there is considerable variation in this respect with different manufacturers. The description of how the different grades chew is very misleading. A material of 15 penetration will not grind between the teeth but will chew hard, while a material of 50 penetration will chew quite soft. and 75 penetration is about as soft as can be chewed without sticking to the teeth.

The statement relative to sheet-asphalt paving, where the author says, "Neither the dust nor bituminous cement should be present in excess, as these tend to make the mixture too smooth to form a proper bond with the foundation," is incorrect. In the first place, the normal mixture of a sheet-asphalt pavement does not adhere to the foundation and, contrary to the statement of the author, an excess of bitumen would tend to cause the mixture to adhere. The objection to the use of too much bitumen is that is produces an unstable, soft pavement.

The average penetration of the bituminous cement for sheet-asphalt paving is given as 35 to 77° F. This is very much too low, and is only used in pavements for the very heaviest traffic. Fifty-five penetration is about the average. The limitations of penetration at 32, 77 and 115° F. of the bituminous cement for bituminous macadam are so limiting that they exclude many of the better-grade asphalts. Several other tables giving the physical characteristics of asphalt are also open to this criticism.

The method described of laying wood block in a tar cushion, if followed, would be likely to result in having the pavement slide around on the foundation. The safest way, and the one that has been adopted as standard of late, is to coat the smoothly prepared foundation with as thin a layer of coal-tar pitch as possible and lay the blocks directly on this and not on a thick pitch cushion sprinkled with sand.

The book will be found of value to all who are interested in the subjects treated. Engineers, architects and contractors can inform themselves on the technology of bituminous paving, waterproofing, roofing, paints, insulation, etc., and on the origin and processes of manufacturing the various ingredients used in these arts. The manufacturer of products in which bituminous materials are used can enlarge his knowledge on how such substances are produced and of their chemical and physical properties, which knowledge may enable him to improve his own products. The technologist will find the book of value as a ready reference for methods of analysis and for the preparation of bituminous compounds. The many references throughout the text add greatly to the value of the book, and will be found most helpful to anyone wishing to make a more thorough study of the subject. Another excellent feature is the system used throughout the book of placing a number opposite all results of tests.

## Water Disinfection by Chlorination

By Frank E. Hale
Director of the Mount Prospect Laboratory, Brooklyn, N. Y.

CHLORINATION OF WATER—By Joseph Race, F.I.C., City Bacteriologist and Chemist, Ottawa; Captain Canadian Army Hydrological Corps; Member of Committee Standard Methods of Analysis, American Water-Works Association. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 158; illustrated. $1.50.

The author has filled a niche which needed filling. Though this is a small book, every phase of chlorination seems to be covered. Many interesting and useful data have been gleaned from the numerous scattered publications containing information on the subject. Much original work is also included. At the end of each chapter is a short bibliography.

It is perhaps natural that the author should give credit to England for first employing chlorine in the disinfection of water, at Lincoln, in 1904-5, although it was in America, since 1908-9, that the importance of the method was first realized and low dosage utilized, so much so that London commenced only in 1916 to chlorinate its supply and Europe, as the book states, did not realize its importance until the war necessitated such action.

In the second chapter is brought together considerable interesting evidence on the old question as to whether oxygen or chlorine is the important active element in the hypochlorites. Such evidence as is contained in Table III appears to be inconclusive, as insufficient data are included. For example, permanganate in acid solution yields five oxygen atoms, in alkaline solution only three. No mention is made of the conditions of the experiment. The table shows the effect of relative stability, or rapidity of action, of two oxidizers rather than the amount of relative work done, since after

sufficient time the results are alike for practically the same oxygen content.

The chapter on dosage throws a considerable light on the effect of organic matter, temperature, admixture, time and light. Particular attention should be paid by operators to the statement on admixture, pp. 41 and 42.

Aftergrowths receive several pages in the chapter on "Bacteria Surviving Chlorination." The absence of sanitary significance is mentioned. The chapter on "Complaints" is particularly complete, referring not only to taste and odor and means of correction, but also to the effect of chlorination on fish life, plants, animals and corrosion. The chapters on "Bleach Treatment" and "Liquid Chlorine" contain information probably more generally familiar. So up to date is the book that reference is made to the mobile motor-truck filter and sterilization units employed by the United States Army late in the war. Possibly not so familiar is the chapter covering the electrolytic processes. The Montreal plant is described, with cost data.

The chapter on "Chloramine" (which employs ammonia with bleach) contains the results of this very recent method of chlorination developed by Race. Judgment upon this method must be withheld, since the most recent tests of its efficiency tend to show very little or no greater efficiency than that obtained by other forms of chlorine. Particularly important is the question of cost as well as the handling of two solutions instead of one. Its effect on aftergrowths may be due to greater stability. Under "Results Obtained" the author lays stress on reduction in cost of filtration by the use of chlorine and consequent increase in filter capacity by increase of load. The last two pages contain a very sane statement on the limits of use of chlorination.

The author deserves praise for producing so readable a book, covering so much ground in so few pages.

## The Shipbuilding Art

PRACTICAL SHIP PRODUCTION—By A. W. Carmichael, Lieutenant Commander, Construction Corps, U. S. N., Member Society of Naval Architects and Marine Engineers. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth; 6 x 9 in.; pp. 252; illustrated. $3.

To furnish the great army of new workers in the shipyards with a sound elementary introduction to the conceptions and methods underlying the construction of modern vessels, the Emergency Fleet Corporation last year issued a little pamphlet entitled "Shipbuilding for Beginners." Precisely the same motive thought, carried out very much more fully, is embodied in the present book. It is still a Shipbuilding for beginners, but it will carry them far into the art, and is capable of developing their ideas and stimulating their thoughts in highly effective manner to the point of a live understanding of shipyard requirements.

A rough notion of what the book contains may be gleaned from the chapter headings: Requirements of Ships, General Description of Ships, Structural Members, Design, Shipyards, Preliminary Steps in Ship Construction, and The Building of Ships. The first two chapters and the one on design, except for a short section describing the materials used in ship construction, are likely to be of less immediate value to the engineer than the other five. The last named, illustrated with many sketches of structural parts, of tools, of good and defective rivets, of bending-slab operations, and other vital matters in hull construction, should prove permanently valuable in tying together the structural engineer and the shipbuilder.

## Condensed Handbook of Iron and Steel

IRON AND STEEL: (A Pocket Encyclopedia) Including Allied Industries and Sciences. By Hugh P. Tiemann, B.S., A.M., with an Introduction by Henry Marion Howe. Second Edition, Enlarged and Revised. New York: McGraw-Hill Book Co. Flexible Cover, Pocket Size; 5 x 7 in.; pp. 514; illustrated. $4.

Having taken a commanding position in the ironworking industries in its first edition (see *Engineering News* of Dec. 15, 1910, p. 58 of the Engineering Literature Supplement) Tiemann's glossary and manual as now revised and rewritten makes an even stronger claim to this position. The author has evidently labored with care and devotion to bring the work up to date and to give proper recognition to the increased importance of the scientific aspect of iron, as represented in metallography. Incidentally, he has amplified the contents of the book considerably, by adding mill terms used in various special branches of the art as well as by expanding the monographs on separate scientific and practical phases of the subject—as Chemistry, Rolling, Heat Treatment, Special Steels. By a short introductory outline of iron metallurgy he has, furthermore, provided a valuable means of coördination. Altogether, the result of the revision is a book that is indispensable to everyone engaged in iron metallurgy.

In its present form the book is essentially a handbook, or highly condensed treatise, with an alphabetical arrangement of sections and with a directly incorporated index. The glossary, though important, is subordinate to the special discussions of the larger individual subjects, which, though arranged in their proper alphabetical position in the glossary, form a series of chapters on the several parts of the entire subject. Of the minor items, forming in number by far the larger part but in space occupying the smaller part of the total, a great number are merely cross-index entries, which refer to the appropriate point in one of the special discussions for the definition and explanation of the term in question.

## Another Novel With an Engineer as Hero

THE GREAT HUNGER—By Johan Bojer. Translated from the Norwegian by W. J. Alexander Worster and C. Archer. New York: Moffat, Yard and Co. Cloth; 5 x 8 in.; pp. 327. $1.60.

Although the hero is a great engineer, this Norwegian story keeps engineering work in the background and depicts a lifelong soul hunger which not engineering achievements, wealth, wife or children appease. The reader is told something of the technical education of the hero, and gets glimpses of his work as a builder of a dam on the Nile and later as an engineer-contractor who ruined himself financially on what was perhaps a hydro-electric plant in Norway. Finally the "great hunger" is satisfied by a simple and secret act of self-sacrifice for a man who had done a great injury to the hero. The story is simply but strongly told.

## Books on Ships and World Trade

The Free Public Library of Newark, N. J., has compiled for the United States Shipping Board lists of books on (1) "Ships, Commerce and the Merchant Marine; (2) "World Trade"; (3) "Foreign Countries." Each book is briefly outlined. Prices and publishers are given. The compilations were made by Miss M. L. Prevost, under the direction of John Cotton Dana, librarian. Requests for the pamphlets should be addressed to the library.

# PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be obtained without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or, in case of books or papers privately printed, then to the author or other persons indicated.]

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION: Proceedings of 28th Annual Convention, 1918—Chicago, Ill.: C. A. Lichty, Secretary. Cloth, 6 x 9 in.; pp. 196; illustrated.

THE AMERICAN YEAR-BOOK: A Record of Events and Progress for 1918—Edited by Francis G. Wickware, B.A., B.Sc. With Coöperation of a Supervisory Board Representing National Learned Societies. New York and London: D. Appleton and Co. Cloth; 5 x 8 in.; pp. 850. $3.50.

The ninth issue of this annual, like the earlier ones, has sections on engineering, Federal, state and local Government activities, public resources and public works, besides many other subjects.

BENGAL SMOKE-NUISANCES COMMISSION: Annual Report, 1917-18—Calcutta, India: The Commission. Paper; 9 x 12 in.; pp. 5. Price, 5 annas; or 6 pence.

THE COLLEGE OF ENGINEERING AND EXPERIMENT STATION, UNIVERSITY OF ILLINOIS: A Pictorial Description. Urbana, Ill.: The College. Paper; 6 x 9 in.; pp. 62; illustrated.

CONSERVATION COMMISSION, STATE OF NEW YORK: Annual Report, 1918. Albany, N. Y.: The Commission. Paper; 6 x 9 in.; pp. 205; illustrated.

DIRECTOR OF THE NATIONAL PARK SERVICE: Report to the Secretary of the Interior, June 30, 1918. Washington, D. C.: Department of the Interior. Paper; 6 x 9 in.; pp 284; illustrated.

DOMINION WATER POWER BRANCH: Annual Report, March 31, 1917. Ottawa, Canada: Department of the Interior. Paper; 7 x 10 in.; pp. 106; illustrated.

DRAINAGE IN MICHIGAN—By Dalton G. Miller and Perry T. Simons, Senior Drainage Engineers, U. S. Department of Agriculture; Prepared Under the Terms of an Agreement Between the Michigan Geological and Biological Survey, R. C. Allen, Director, and The United States Department of Agriculture, Bureau of Public Roads, [late] Logan Waller Page, Director. Prepared Under Direction of S. H. McCrory, Chief of Drainage Investigations. Lansing, Mich.: Michigan Geological and Biological Survey. Cloth; 6 x 9 in.; pp. 133; illustrated.

FIRST BIENNIAL REPORT OF THE CALIFORNIA HIGHWAY COMMISSION: A Subdivision of the Department of Engineering of the State of California; to Accompany the Sixth Biennial Report of that Department, Dec. 31, 1918. Sacramento, Calif.: The Commission. Paper; 6 x 9 in.; pp. 142; illustrated. Folding map in pocket showing state highway systems.

Reviews commission's work to date. Contains reports on the various phases of the work, tables of costs and tests of material.

GOVERNMENT OWNERSHIP OF PUBLIC UTILITIES IN THE UNITED STATES—By Leon Cammen, M. A., Associate Editor of the *Journal* of the American Society of Mechanical Engineers; Member New York Academy of Sciences, Etc. New York: McDevitt-Wilson's. Cloth; 6 x 9 in.; pp. 142. $1.50.

IRRIGATION ENGINEERING—By Arthur Powell Davis, D. Sc., M. Am. Soc. C. E.; Director and Chief Engineer U. S. Reclamation Service, Author of "Irrigation Works Constructed by the United States," etc., and Herbert M. Wilson, C.E., M. Am. Soc. C. E.; Former Chief Engineer and Irrigation Engineer, U. S. Geological Survey; Author of "Topographic Surveying," etc. Seventh Edition, Revised and Enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 640; illustrated. $4.50.

LABOR LOSS: Handbook on Employment Management in the Shipyard; Dealing with Modern Methods and Practices of Employment Management. Philadelphia, Penn.: U. S. Shipping Board, Emergency Fleet Corporation. Paper; 8 x 10 in.; pp. 30; illustrated.

THE LARGER UNDEVELOPED WATER POWERS OF TENNESSEE—By J. A. Switzer, Professor of Hydraulic Engineering, University of Tennessee, and Hydraulic Engineer of the Tennessee State Geological Survey. Nashville, Tenn.: Geological Survey. Paper; 6 x 9 in.; pp. 35; illustrated.

Reprint of a paper, which was prepared for presentation at the thirty-third general meeting of the American Electrochemical Society, held at Knoxville, Tenn., Apr. 30, 1918. The expense of the field and office work was met by the Knoxville Board of Commerce.

MAN TO MAN: The Story of Industrial Democracy—By John Leitch. New York: B. C. Forbes Co. Cloth; 5 x 8 in.; pp. 249. $2.

MICHIGAN STATE BOARD OF HEALTH: Forty-Sixth Annual Report of the Secretary, June 30, 1918. Lansing, Mich.: The Secretary. Cloth; 6 x 9 in.; pp. 180; illustrated.

MOTOR TRANSPORTATION FOR RURAL DISTRICTS—By J. H. Collins, Investigator in Market Surveys. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 x 9 in.; pp. 32; illustrated.

On motor-express routes. Some of the topics covered are selection of the route, advance estimates of operating costs, selection of equipment, determination of rates, bills of lading, and operation methods. Interesting to both those who are now operating and those who are intending to establish truck routes.

NEW YORK STATE ENGINEER AND SURVEYOR: Supplement to the Annual Report for 1917. Albany, N. Y.: State Engineer and Surveyor. Cloth; 6 x 9 in.; pp. 470.

NOTES ON TRANSPORTATION, WITH ESPECIAL REFERENCE TO TRANSPORTATION PROBLEMS ON CANE SUGAR PLANTATIONS—By Capt. Carl B. Andrews, Engineer Corps, U. S. A. Honolulu, T. H.: Hawaiian Engineering Association. Paper; 6 x 9 in.; pp. 63; illustrated.

Water transportation in flumes and such other means of transportation as steam, electric, and funicular railways, as well as cableways, are considered. The treatment is in part descriptive and in part it gives design data. But little is given on the specific problems of moving cane, and most of that seems to be under "Flumes," where there is also considerable on flume hydraulics in general.

PRACTICAL SHIP PRODUCTION—By A. W. Carmichael, Lieutenant Commander, Construction Corps, U. S. Navy, Member Society of Naval Architects and Marine Engineers. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd. Cloth; 6 x 9 in.; pp. 252; illustrated. $3.

PRINCIPLES OF COMBUSTION IN THE STEAM BOILER FURNACE—By Arthur D. Pratt. New York: The Babcock & Wilcox Co. Cloth; 6 x 9 in.; pp. 114. Free on request.

RECLAMATION BOARD OF CALIFORNIA: Fourth Biennial Report, 1918. Sacramento, Calif.: The Board. Paper; 6 x 9 in.; pp. 53; illustrated.

Deals with progress and status of flood control in the Sacramento and San Joaquin Drainage District.

SAVING STEAM IN INDUSTRIAL HEATING SYSTEMS.—Prepared by the U. S. Fuel Administration in Collaboration with the Bureau of Mines. Washington, D. C.: Bureau of Mines. Paper; 6 x 9 in.; pp. 14; illustrated. 5c. from Superintendent of Documents.

SEWAGE-DISPOSAL PROBLEM OF NEW HAVEN: Report, 1918—By C.-E. A. Winslow, D.P.H., Professor of Public Health, Yale School of Medicine, and F. W. Mohlman, Ph.D., Chemist, New Haven Experiment Station. New Haven, Conn.: The Authors. Paper; 6 x 9 in.; pp. 97; illustrated.

Describes experimental sewage-treatment plant, summarizes results and gives conclusions and recommendations. In briefer form, much of the same information appeared in *Engineering News-Record*, Jan. 2, 1919, p. 32.

SMALL SAWMILLS: Their Equipment, Construction and Operation—By Daniel F. Seerey, Logging Engineer. Washington, D. C.: U. S. Department of Agriculture, Bulletin No. 718. Paper; 6 x 9 in.; pp. 68.

STATE ENGINEER OF ARIZONA: Third Biennial Report, 1916-17 and 1917-18. Phoenix, Arizona: B. M. Atwood, State Engineer. Paper; 6 x 9 in.; pp. 243; illustrated.

A cost distribution system, instructions to highway engineers and the results obtained with convict labor—which are in general satisfactory—are included with the routine reports of work done.

STATISTICAL REPORT OF LAKE COMMERCE PASSING Through Canals at Sault Ste. Marie, Michigan and Ontario, During Season of 1918; With a Supplementary Report of Commerce Passing Through the Detroit River—Prepared Under Direction of L. C. Sabin, District Engineer, U. S. Engineer Office, Sault Ste. Marie, Mich. The Engineer. Paper; 6 x 9 in.; pp. 30; illustrated.

STATISTICS OF MANUFACTURES: Report for 1917—By Charles F. Gettemy, Director of the Bureau of Statistics. Boston, Mass.: The Bureau. Paper; 6 x 9 in.; pp. 129.

TABLE OF UNIT DISPLACEMENT OF COMMODITIES—Washington, D. C.: Bureau of Standards. Paper; 7 x 10 in.; pp. 67. Copies free upon request.

An alphabetical list of commercial commodities, giving the weight per cubic foot, cubic feet per long ton, cubic feet per short ton, and in many instances how the commodity is packed for shipment.

TARVIA ROAD BOOK: For Highway Engineers, Contractors and Road Builders. New York: The Barrett Co. Leather; 3 x 6 in.; pp. 70. Free upon request.

A handy pocket book primarily for the use of engineers who are applying tarvia to their roads, but containing some more general data. Among the tables are: Quantity of tarvia per mile; distance covered by various tank capacities; weight per cubic yard of various substances; spacing for covering material in half-ton piles; costs per mile at price per square yard. Also contains specifications for applying tarvia.

TESTS OF HOLLOW BUILDING TILES—By Bernard D. Hathcock, Laboratory Assistant, and Edward Skillman, Laboratory Assistant, Bureau of Standards. Paper; 7 x 10 in.; pp. 29; illustrated. Copies free upon request.

Records and discusses about 250 compression and absorption tests.

THE USE OF WOOD FOR FUEL: Compiled by the Office of Forest Investigations. Washington, D. C.: U. S. Department of Agriculture. Paper; 6 x 9 in.; pp. 40; illustrated. 10c. from Superintendent of Documents.

WATER STORAGE AND THE WATER CODE—By G. E. P. Smith, Irrigation Engineer. Tucson, Ariz.: University of Arizona. Paper; 6 x 9 in.; pp. 7; illustrated.

WATER SUPPLY PAPERS—Nathan C. Grover, Chief Hydraulic Engineer. Washington, D. C.: U. S. Geological Survey. Paper; 6 x 9 in.; illustrated.

No. 411: 1915. Part XI. Pacific Slope Basins in California. H. D. McGlashan and F. F. Henshaw, District Engineers. Prepared in coöperation with the State of California; pp. 345. No. 422: Ground Water in the Animas, Playas, Hachita, and San Luis Basins, New Mexico—By A. T. Schwennesen; with Analyses of Water and Soil by R. F. Hare. Prepared in coöperation with the New Mexico Agricultural Experiment Station; pp. 152. No. 427: Bibliography and Index of the Publications of the United States Geological Survey Relating to Ground Water—By Oscar E. Meinzer; pp. 169.

# SOCIETY SERVICE

*A Section Dealing with the Results of Teamwork by Technical Men*

## Send Questionnaire on Legislation

To the membership of the Montreal branch of the Engineering Institute of Canada was sent a questionnaire, in anticipation of the meeting of the committee on legislation on Apr. 5, in order to provide information for the representatives on that committee. The following questions were used:

"1. Are you in favor of a closed corporation for engineers having responsible charge of engineering works?

"2. If so, do you favor legislation embracing all engineering works, or only public works?

"3. In the event of the majority of the members of the institute residing in Quebec declaring in favor of a closed corporation, what are your opinions on the following questions: (a) Do you consider that the only method of entrance into the engineering profession should be through the engineering colleges? (b) If not, do you think that candidates who do not follow college engineering courses should be obliged to pass an examination for admission to study somewhat along the lines of the matriculation examinations required for university entrance? (c) Do you think that candidates should be required to pass an examination for admission to practice, similar to the examinations required by the bar and medical associations? (d) Should candidates be obliged to serve a period of apprenticeship or employment under an engineer before being allowed to take the final examinations for admission to practice? (The word practice is understood to mean taking responsible charge of engineering works). (e) If in favor of examination, do you consider that these should be held by the Corporation only or by a joint board of the members of the Corporation and representatives of the McGill and Laval faculties of applied science? (f) Do you consider that graduates of engineering schools should be exempted from any or all the examinations? (g) If so, from what examinations should they be exempted? (h) Do you think that graduates of engineering schools should be required to prove that they have had experience under some engineer before being admitted to take charge of engineering work?"

## Western Society Studies Legislation

A "public affairs" meeting to inform the members of the Western Society of Engineers concerning bills and projects now before the Illinois legislature is the latest development in the broadening activities of the society. That it sees the need of extending the field of thought of the engineer, who has been too much centered in his technical work, and that this applies especially to the young men, was the keynote of the opening remarks by the president, A. S. Baldwin, at the recent meeting. Brief notes of several bills relating to waterways, licensing, housing and other subjects were presented by the secretary. State Senator James J. Barbour, who attacked particularly the present housing bill and some labor bills, expressed the opinion that most legislation is so bad that the community would benefit if the legislature should meet only at 10-year intervals. The housing bill was criticized in form but not in principle by H. K. Holsman, secretary of the Chicago chapter of the American Institute of Architects.

## Society Backs Railway Organization Plan

A comprehensive plan for railway organization was outlined by Dean William G. Raymond at the annual meeting of the Iowa Engineering Society, and the society, believing that it contains ideas and suggestions which may be of service in the solution of the present difficult railway problem, has had the plan printed and distributed (through its publicity committee) to newspapers and periodicals. The society has also brought the plan to the attention of members of Congress, as well as of Congressional committees dealing with the subject. In general, it provides for a Federal holding company in financial control, with separate management for each property under the direction of a board on which both the stockholders and the employees are represented.

## Co-operation at Pittsburgh Proposed

Engineers in Pittsburgh who are working for progress in professional organization have taken active steps toward bringing about local and state coöperation. The Pittsburgh Association of Members of the American Society of Civil Engineers delegated a committee to confer with the Engineers' Society of Western Pennsylvania with a view to associating all local technical bodies in a federation for professional service and cooperation in city and state. The latter society has the matter under advisement.

# LETTERS TO THE EDITOR

*Comment on Matters of Interest to Engineers and Contractors Will Be Welcome*

## On The Strength of Concrete in Shear

Sir—The tests on reinforced-concrete beams described in your issue of Feb. 27, 1919, p. 430, by W. A. Slater, and your editorial of the same date, would seem to warrant the use of higher units on concrete in shear than those in common use. Before adopting higher unit stresses it would be well to look into these tests and examine the results to see just what they do disclose.

On the face of it the tests seem to show that the concrete of these beams carried shears amounting to more than 2000 lb. per square inch in some cases. It must be remembered, first, that the concrete webs had failed long before this shearing value was reached, and, second, that these shearing units are a conventional thing and not the actual shear on the concrete section.

The thing that was subject to shear was a system of very closely spaced web members, unlike the stirrups in an ordinary beam both because of the close spacing and the large section. If these web members had been spaced as they usually are in reinforced-concrete beams, there would have been a chance for the beam to break between two web members, and quite a

different story might have been told of the capacity of concrete to carry shear.

The only thing of interest in tests of this sort for ship work is what the unit shear on the actual area of concrete is at the first crack, for it is the first crack of the hull of a ship that would let in the ocean. It would not matter particularly whether there was a residual strength after the first crack from shear of 10 or 20 times this real ultimate. For it is the first crack that tells what the concrete will stand, and, as Professor Talbot showed some years ago in a series of tests, stirrups do not perform any office until the concrete web has failed.

The test results show that all of the beams had cracked when the shear on the nominal resisting section was 400 lb. per square inch. How much earlier in the test this failure had occurred is not stated.

The section assumed in shear by Mr. Slater is only the web of the beam. Now, there are large heads on these beams which have an area much larger than the web. Why should a broken and utterly failed web be considered as taking so much shear per square inch when the only thing that is approximately whole is the two heads of the beams with their steel connecting web members?

If there were no concrete web whatever in these beams, they would probably take nearly the same ultimate load. This supposed shearing strength of concrete could then be increased *ad libitum* (by using a thinner web) just as some laboratory tests made some years ago attributed all of the tensile resistance in a whole reinforced-concrete beam to the reinforcing steel, and as, even at this date, the tensile resistance of flat slabs is attributed to the reinforcing steel aided by the opinions of adroit mathematicians.

Pittsburgh, Penn. EDWARD GODFREY.

[This letter was submitted to Mr. Slater, who has replied as below. Note should be made of the typographical corrections of the original article appearing in *Engineering News-Record* of Mar. 20, 1919, p. 570. —EDITOR.]

Sir—On reading Mr. Godfrey's letter, I am convinced that he failed to see the significance of the data presented in this paper, or else he ignored the data entirely. In order to bring this out, I wish to call attention to the nature of many of his statements, in approximately the order in which he makes them.

1. "The thing that was subject to shear was a system of very closely spaced web members. . . . If these web members had been spaced as they usually are in reinforced-concrete beams . . . quite a different story might have been told, etc."

The data in the paper refer to a system with closely spaced web members, and no conclusion on any other kind of system was attempted. The article in question even calls attention to the importance of extending the investigation to determine "the effect of variation of spacing of stirrups."

2. "It is the first crack of the hull of a ship that would let in the ocean." Concrete ships are not free from cracks, and yet they do not sink.

3. "Stirrups do not perform any office until the concrete web has failed."

If by "failure" he means the formation of tension cracks the statement is practically correct. But this is quibbling, for it is common knowledge that a reinforced-concrete beam has not failed when the first tension crack occurs. The test data given should remove the last doubt on this point. The first tension crack occurred at shears generally ranging from 200 to 300 lb. per square inch, while the shear at maximum load for the same beams ranged from 950 to 2400 lb. per square inch.

4. "Now, there are large heads on these beams which have an area much larger than the web. Why should a broken and utterly failed web be considered as taking so much shear per square inch when the only thing that is approximately whole is the two heads of the beam with their steel connecting web members?"

Mr. Godfrey would have found by reading the article that I recognized that the shearing stress given "must be somewhat in error, etc." The only difference of opinion is as to how large this error is. I judge that Mr. Godfrey thinks the flanges carried most of the shear. Mr. Godfrey will perhaps recall that approximately the same relation between flange area and web area exists with a steel plate-girder as with the reinforced-concrete beams under discussion; yet I doubt if he would give much shearing value to the flanges of a steel plate girder.

Mr. Godfrey assumes that the two heads were "approximately whole" when the web was "utterly failed." As a matter of fact, they were not.

5. "If there were no concrete web whatever in these beams, they would probably take nearly the same ultimate load."

Had Mr. Godfrey read the article carefully, he would have noted that beam 4AD1, which was of exactly the type to which he refers, carried 174,000 lb. less load than similar beams (4X1 and 4X2) which had concrete also in the web. That is, he would have noted that the beams with steel alone in the web carried only half as much load as one with a web having the same amount of steel and the concrete in addition.

Not only is Mr. Godfrey's statement at variance with fact, but, further, it is at variance with his own conviction as stated in the *Journal* of the American Concrete Institute for December, 1914, p. 19, where he says: "The Joint Committee report does not state whether the stress in a shear member is shear, or compression, or tension. All three are equally absurd." On this as a basis it is difficult to see why the web reinforcement in these beams carried so much load and why Mr. Godfrey now even expects it to carry so much more load than it did. Perhaps he has torsion in mind.

Philadelphia, Penn. W. A. SLATER.

## Cost-Plus Contracts and Proposals

Sir—E. T. Johnson in your issue of Apr. 3, 1919, p. 683, hits the nail squarely on the head in amusing fashion. I quote his opening paragraph:

"In your issue of Mar. 6, 1919, p. 485, is a communication from J. B. Chaffey, major, Quartermaster Corps, U. S. A., Fort Sill, Oklahoma. He descants upon the beauties of cost-plus contracts. What especially interests me he does not touch upon—that is, how to get one. I am a contractor and tried hard during the war to get a cost-plus contract, not only in construction, but also in spruce production. What I received was a polite bowing out. I could not find any way at all to break in."

Here we have light, not heat. Proposals form a method of selection.

The difficulty, in my experience, is not to find one

good contractor for a project, but to select among a number of good contractors. Proposals naming price and time, from a list of selected contractors, upon properly prepared drawings and specifications by engineer or architect, are the final examination to determine the contractor best qualified, at that particular time, for the particular project.

When this method is not followed your correspondent's query, "How Were Cost-Plus Contracts Obtained?" is always pertinent.

CHARLES H. HIGGINS,
New York. M. Am. Soc. C. E.

## Would Use Surrendered German Warships to Form Training Walls for Channels

Sir—The problem of what to do with the surrendered German warships seems to be causing quite a difference of opinion, and I would suggest that they might be advantageously used as jetties or training walls for the improvement of channels to obtain a greater depth of water over sandy river bars, if sunk in line on each side, taking the place of jetties constructed of logs or stone.

In this position they would serve a double purpose, not only deepening the channel for navigation, but as a monument of the great war, for all ages, and they would become a great attraction for excursionists and sightseers. The submarines and other small captured craft could well be used to fill gaps between the larger ships that might unavoidably occur in sinking them. They would all be linked together with chain cables, and the seacocks opened.

Old vessel hulks have before this time been used in this way, by engineers, on several occasions.

It seems almost a crime to sink these costly ships in the deep sea, when there are so many good uses to which they could be put and at the same time preserve them for their moral and patriotic effect on coming generations. J. FRANCIS LEBARON.

Panama City, Fla.

## Draftsmen Assert Further Unfair Play on Part of Navy Department

Sir—The attention of the International Federation of Draftsmen's Unions, chartered under the American Federation of Labor, has been invited to the article in the letter columns of your issue of Mar. 27, 1919, p. 634, entitled "Navy and Fleet Corporation Unfair to Their Own Draftsmen." I am directed to request the insertion in an early issue of the following statement, in which it is desired to point out and elaborate certain points in the article referred to, and also to bring your article up to date.

The letter by William F. Fox is correct as regards the action of the Navy Department in putting into effect, for the navy yards, bureaus and other offices and stations under that department, the award for draftsmen of the Shipbuilding Labor Adjustment Board, commonly known as the Macy Board.

Furthermore, the letter of Secretary Daniels is, on its face, correct except in one particular. This particular is the last paragraph, which involves two inaccuracies. These are not placed to the discredit of Mr. Daniels, as everyone familiar with department procedure may be certain that Mr. Daniels did not write the letter himself. It is incredible that anyone familiar with the facts "believes" that the Macy Board award has been effected for Government draftsmen. The award which was effected was that of the secondary board mentioned by Mr. Daniels, the so-called Henry Board, which was based, not upon the Macy Board award, but upon the recommendations submitted by the various chiefs of bureaus, industrial managers, commandants, etc. As these recommendations were themselves a cut as compared with the Macy award, and were further cut by the Henry Board, it is easily seen that the Macy award is not in effect in Navy Department offices.

Neither letter brings out the vexatious delay resorted to by the department to avoid putting even the Henry award into effect.

The Macy award went into effect in private yards immediately upon its announcement in October and was retroactive to Oct. 1. It was not approved by the Navy Department until Nov. 12, although the original award was signed by Dr. Marshall as official representative of the Shipping Board and the Navy Department. The instructions of the department were so vague that prompt action by the various yards was impossible. Numerous letters and telegrams between the yards and the department for interpretations of innumerable points were necessary. Owing to the incompetence of the instructions, a month elapsed before any of the yards submitted its recommendations. The total delay so far was about one and one-half months.

The papers were turned over to the Henry Board late in December, but all department activity ceases during the holidays. When this board finally got to work it realized its utter inability to reclassify over a thousand men of whom it had no personal knowledge and no way of knowing the local conditions governing the recommendations for each individual. The board therefore hit upon the expedient of fixing an arbitrary average increase of $1.60 per diem, with this exception, however—yards whose recommendations showed increases averaging over $1.60 were brought down to give about that figure, but those yards whose average increase was less than $1.60 were kept where they were and not brought to this average.

The papers were returned to the department Jan. 17, and two months after the department's approval of Nov. 12. Action was then delayed until Feb. 4, owing to the personal refusal of Mr. Daniels to approve the award of his own board, his opinion being that the award was too high, although it was far below that of the Macy Board, which the Government had forced the private yards to grant some four months previously. Even then Mr. Daniels signed practically under coercion, as the temper of the men had been stretched to the breaking point, and was scheduled to break Feb. 8.

On Feb. 4, however, Mr. Daniels signed a letter putting the Henry award into effect, but as certain revisions in the recommendations were required, it was several days, and in some cases weeks, before the men received the new pay. There was no retroactive feature to compensate them for the long and needless delay.

The draftsmen did not enjoy the fruits of this award in peace for very long, however. On Mar. 13 the department issued a circular letter reducing the force 10%. This was on the eve of Mr. Daniels' departure for Europe, and the answer to all protests has been that Mr. Daniels had issued emphatic orders which could not be changed in his absence.

The reason assigned in the letter was "economy." Let us examine that reason. Draftsmen are paid from an appropriation covering several classes of employees, yet of these only the draftsmen are affected. There are about a thousand draftsmen in the Government service, and as the reduction is 10%, the saving would be the pay of about 100 men. The real reason for the reduction is found in the last part of Paragraph 1 of the letter of Mar. 13, as follows:

"If it is desired to retain the services of any draftsman with a civil-service status, selected for separation in his particular grade, in a lower grade, he may be so reduced only upon his own application or consent, but he shall be considered among the total number of draftsmen in such lower grade in figuring the percentage reduction in that grade."

This is the kernel. The object is to reduce wages and to deprive the draftsmen of the benefits awarded them by an impartial board appointed by the President of the United States. They are offered the choice of having their pay reduced or of losing their jobs in these times of unrest and at the very time when the Government is appealing to private firms to furnish jobs for the unemployed.

INTERNATIONAL FEDERATION OF DRAFTSMEN'S UNIONS,
By Anthony F. Oliver, President; A. H. Miller, Secretary.

3304 20th St., N. W., Washington, D. C.

## Motor Truck Costs Much Higher Than Generally Assumed

Sir—I have read with interest the article in your issue of Feb. 27, 1919, p. 438, entitled "Motor Truck Costs Much Higher Than Generally Assumed." It calls to mind a letter by myself published in *Engineering Record* of Feb. 13, 1915, p. 211, criticising an article in that journal describing the hauling of 400 tons of stone per day with auto trucks for 8.28c. per ton-mile. There was a marked tendency at the time to underestimate greatly the cost of auto-truck haul—a tendency which today is being largely overcome.

Data collected by me on a truck operating for a general contractor from Sept. 1, 1913, to Oct. 1, 1915, harmonize quite closely with those now published by the Motor Truck Association of America in your recent article. This truck, the operation of which furnished the data collected by me, was a five-ton Locomobile truck, which was new when it went into service at the beginning of the period described. During this period, quarter-monthly reports were made by the driver; they gave all data as to loads hauled, daily expenses, mileage, ton-mileage, accounts or individuals for whom work had been performed, etc.

In order to make a comparison of cost with earnings, it was necessary to estimate and charge on this report certain regular rates per mile traveled to care for interest, insurance, depreciation and tires. The charges for the first three of these items were lumped at 10c. per mile. This figure was obtained by dividing the annual cost therefor by the estimated annual mileage. The charge of 6c. per mile for tires was obtained by dividing the cost of a full set of tires by the manufacturers' guaranteed mileage.

The charge for interest, insurance and depreciation proved too low for this particular case, because the truck was not kept steadily engaged. It traveled only 16,242 miles in the 25-month period, and thereby, at the 10c.-per-mile rate, earned only $1624.20 for interest, insurance and depreciation. The charge of 6c. per mile for tires proved higher than necessary, because it was found easy to exceed the manufacturer's guaranteed mileage on tires. Approximately 4½c. would have been a sufficient charge to compensate for tire expense.

The truck was engaged in a miscellaneous lot of hauling, and was seldom long at any particular line of work. The roads were almost always poor and some were almost impassable. It was necessary to provide a helper for the driver during a considerable portion of the time. Gasoline was then 17c. per gallon, as compared with 21c. now, and lubricating oils and distillate, which was used to a large extent instead of gasoline, were correspondingly cheaper. The driver was paid $4 per day and his helper $2.50.

The truck was in actual operation only 450 days, during the 25-month period, and averaged approximately 36 miles per day of operation. The table herewith gives the segregated costs:

OPERATION COSTS PER MILE FOR FIVE-TON TRUCK

| | |
|---|---|
| Driver | $0.111 |
| Helper | .052 |
| Gasoline, distillate and lubricants | .068 |
| Repairs to engine and chassis | .086 |
| Miscellaneous expenses | .013 |
| Charges for interest, insurance and depreciation | .100 |
| Charges for tires | .060 |
| Total cost | $0.490 |

Waterford, Calif. EVERETT N. BRYAN.

## Railway Bridge Impact Allowances

Sir—Referring to the editorial on p. 454 in your issue of Mar. 6, 1919, entitled "Railway Bridge Impact Allowances," I entirely agree with you concerning the fallacy of increasing materially the impact for short spans and decreasing materially that for long ones.

There seems to be a tendency these days to change bridge specifications in most illogical ways—for instance, stressing steel 20,000 lb. per square inch for tension members and less than 12,000 lb. per square inch for short compression members, without there being any legitimate foundation for such a radical modification. While I am not at all opposed to making changes in standard bridge specifications that are really improvements, I am decidedly against altering anything therein until after it has been shown that there is a valid *raison d'être* for the innovation—especially when the suggested modification militates against true economy.

Recognizing that both of the old standard impact formulas

$$I = \frac{30{,}000}{L + 300} \quad \text{and} \quad I = \frac{40{,}000}{L + 500}$$

for railway bridges with open floors give percentages of impact which are too low for very short spans and too high for long ones, according to the A. R. E. A. tests, a few years ago I established the formula

$$I = \frac{16{,}500}{nL + 150}$$

where $n$ is the number of tracks and $L$ is the span length in feet. For single-track spans of 15 ft., which is about as short as railroad spans are made, this formula gives percentages of impact equal to 100; and very few impact records have ever exceeded that amount. At the same time, for long spans the formula holds fairly well, the curve passing above all the records taken from single-track railroad bridges. By referring

to my diagram on p. 926 of your issue of Nov. 21, 1918, the correctness of these statements will be seen; and it will be there noticed that, while the proposed A. R. E. A. formula

$$I = \frac{100}{1 + \frac{L^2}{30{,}000}}$$

passes above practically all of the plotted points for spans of 200 ft. or less, it drops below two of them at a span length of 300 ft. In my opinion, it gives results that are too low for long-span bridges. For instance, in a 600-ft. span the percentage it provides for the truss-chords is only 7.7, while by my formula it is 22 for single-track structures and 12.2 for double-track structures.

For short spans the new A. R. E. A. formula and mine for single-track structures coincide at a length of 16 ft. and again at a length of 166 ft.; but between these two lengths my formula is as much as 11 points lower, and averages about 7½ points lower over the whole distance of 150 ft. As my curve is above almost all the plotted points, I claim that my formula is better than the proposed A. R. E. A. formula in that it tends to economy of metal.

In considering the advisability of a general adoption of the proposed A. R. E. A. impact formula with its somewhat extravagant employment of metal for short spans, it must be remembered that the day of the electrification of main-line railroads is not far distant, and that, as far as we know at present, the impact from electric locomotives is only about one-third as great as that from steam locomotives. When the time comes for operating electric trains over bridges designed for steam live loads, there will, of necessity, be a large surplus of strength in short spans and in the floor systems of all spans; consequently, it behooves us to keep down the said surplus as much as we consistently can—and we should not be doing so by adopting for impact the new A. R. E. A. formula.

J. A. L. WADDELL,
Consulting Engineer.

Kansas City, Mo.

## Earthwork Computations Simplified

Sir—The common average-end formula for volumes for $n$ stations used in earthwork computations may be written in three ways, as follows:

$$\frac{A_0 + A_1}{2} l_1 + \frac{A_1 + A_2}{2} l_2 + \ldots . \frac{A_{n-1} + A_n}{2} l_n \quad (1)$$

$$A_0 \frac{l_1}{2} + A_1 \frac{l_1}{2} + A_1 \frac{l_2}{2} + A_2 \frac{l_2}{2} + \ldots . A_n \frac{l_n}{2} \quad (2)$$

$$A_0 \frac{l_1}{2} + A_1 \frac{l_1 + l_2}{2} + A_2 \frac{l_2 + l_3}{2} + \ldots . A_n \frac{l_n}{2} \quad (3)$$

By formula 1 each section will have two areas to be added and volumes computed. By formula 2 two volumes for each station, and for substations one or two multiplications and the addition of volumes are required.

By formula 3, however, one volume is computed for each station, and never but one multiplication for a substation. The volume recorded for any station will be the section area for the station multiplied by half the distance from the previous station to the one next following. This "half distance" will of course be 100 ft. for full stations. Tables of volumes of level or three level sections 100 ft. long may be used. For calculations based on irregular areas, taken with the planimeter or otherwise, the formula is especially simple.

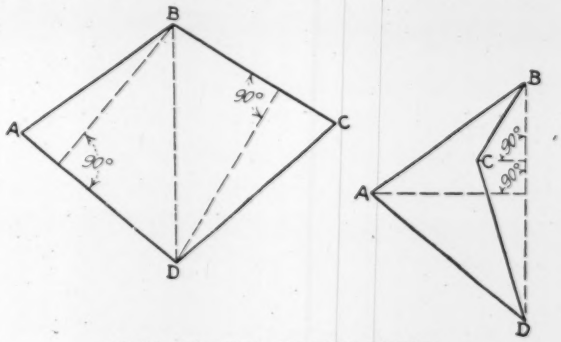
The writer's experience prompts the suggestion that the time saved by the use of formula 3 would justify its more extensive employment.

J. H. DORROH,
Dean, School of Engineering,
University of Mississippi.

University, Miss.

## To Compute Area of Four-Sided Figure

Sir—It seems to have escaped the notice of writers of textbooks on surveying, and of computers generally, that the area of any four-sided figure may be obtained and the traverse checked in a much shorter way than by latitude and departure and the D.M.D. method. The




AREA BY SUM OF TRIANGLES

double area of any quadrilateral not containing a reëntrant angle is equal to the sine of any angle into its adjacent sides plus the sine of the opposite angle into its adjacent sides. Thus, from the diagram:

$2 \times \text{Area} = \text{A D} \times \text{A B} \sin \text{A} + \text{C D} \times \text{C B} \sin \text{C}$

For the case of a reëntrant angle, note that in using angles A and C, the double areas of triangles A B D and C B D, respectively, are obtained. The area is then half the difference of the two products.

If now we take the other two angles of the quadrilateral, B and D, and their adjacent sides, we shall obtain the same double area, provided the traverse is correct, thus checking the first computation and the traverse at the same time.

By the D.M.D. method we should have arranged nine columns and 42 items. This method requires only about one-fourth the labor.

C. K. AVERILL.

Bridgeport, Conn.

### Quarantine Against Influenza in Alaska

Quarantine against influenza is said to have kept the disease out of Fairbanks and Nenana, Alaska. According to a statement in the *Alaska Railroad Record*, the official publication of the Alaska Engineering Commission, every person in each city had to wear on hat or coat a blue ribbon lettered "Health Department," which was purchased from the department for a fee of $1, or $2 for a duplicate in case of loss. Persons failing to obtain and wear the ribbon were subject to arrest and quarantine confinement. Civilian sentries guarded all the trails, and persons entering either city were detained five days in quarantine, being then permitted to proceed if no symptoms of the disease had developed. The fees went toward the expense of guarding the trails and quarantining travelers.

# HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

## Simple Heating and Ventilating System for Contractor's Hospital

By Dr. J. M. Stadter
Wilmington, Del.

EVEN distribution of stove heat and uniform ventilation without drafts were secured in a knocked-together construction camp hospital by the simple arrangement of stovepipes and wind shields illustrated by the accompanying view. The hospital was a two-story timber building about 90 x 20 ft., with a ward on each floor.

Exactly similar heating and ventilating arrangements were provided for the two wards. The illustration shows the lower ward. About 65 ft. of the length of each ward was occupied by cots, the remaining 25 ft. at one end being partitioned into toilets, chart room, locker and bathroom.

Wood-burning stoves, A and B in the illustration, were set about 40 ft. apart in the 65-ft. space occupied by cots. The pipe from each stove was carried up to the ceiling at CC, and then along the ceiling about 26 ft. toward the other stove, to DD, and thence to EE, and through the walls to outside tile chimneys. With dampers set near the outside walls this arrangement gave about 40 ft. of pipe radiation from each stove, and gave a very even distribution of heat—usually difficult with stoves.

Ventilation was accomplished by equally simple means. Single sash were used for the windows and were hinged at the bottoms to swing into the room. Galvanized-iron shields were then fitted to each window as shown at FF. The air entering was deflected toward the ceiling, and a good circulation was secured without direct drafts on the cots.

This hospital has the noteworthy record, for a contractor's hospital, of having handled 285 cases of influenza, of which 124 cases were serious, with only four deaths. The hospital was constructed and equipped for operation in 48 hours. It was built at Union Park Gardens, a housing project of the Emergency Fleet Corporation located near Wilmington, Del.


**Other Articles in This Issue of Interest to Contractors:**

Labor-Saving Machinery Used in Building Houses — Page 753

Public Works Department Would Spend $125,000,000 — Page 757

Dismantle Bridge Spans Carefully for Use Elsewhere — Page 765

How 45-Ton Boilers Were Rolled 21 Miles Along Coast — Page 772

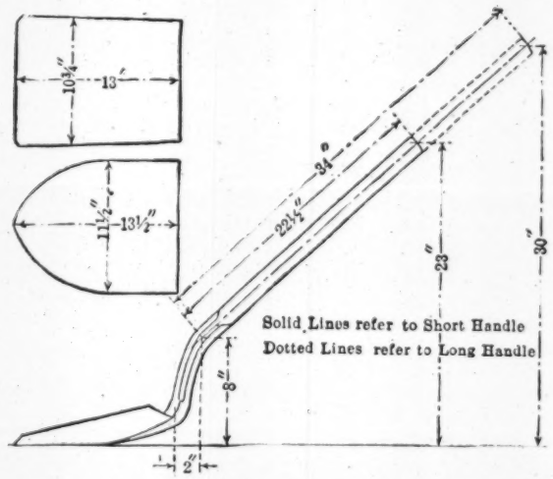
Cost-Plus Contracts and Proposals (Letter) — Page 784

Motor-Truck Costs Much Higher Than Generally Assumed (Letter) — Page 786


## Scoops Found Slower Than Shovels For Handling Ore

BEST results applicable to construction operations such as mucking rock tunnels and loading broken stone have been determined in shoveling ore at the Tyrone, N. Y., mines of the Phelps Dodge Corporation. Investigation was confined largely to comparison of work with No. 2 scoops and No. 4 shovels, under various conditions of loading. For jobs of less than four hours' duration a greater tonnage can be handled with a scoop, but for longer jobs the shovel is greatly superior, since, as the day progresses, the percentage of time required for resting becomes greater with the scoop than with the shovel. In general, for shovels smaller

WIND SHIELDS AND STOVEPIPES REGULATE AIR AND TEMPERATURE IN CAMP HOSPITAL




DESIGN OF SHOVEL BEST ADAPTED TO MINING WORK

than No. 4 (21-lb.) the tonnage handled per shift is, approximately, directly proportional to the shovel capacity. The design of shovel determined as best is shown by the drawing.

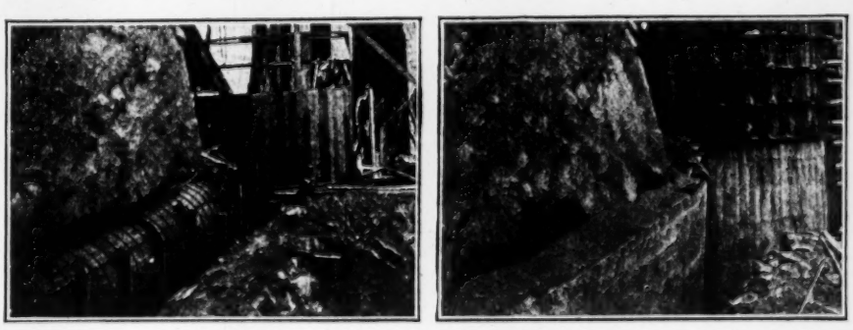
Other instructive facts brought out by the tests were: Owing to poorer light and air, greater humidity, increased temperature and other conditions prevalent underground, the tonnage handled is 20½% less than on the surface. Decrease in shoveling speed due to 1-ft. increase in distance of throw was 2½% for the scoop and 1.8% for the shovel; underground the corresponding percentages were 4.4% and 3.2%. Of a 7½-hour actual working day the men are shoveling only 82½% of the time, the remaining time being spent in nonproductive occupation. This figure is the average of several hundred man-shifts. In loading wheelbarrows a throw of 3 ft. gave the best results. In loading cars 42 in. high the best distance to maintain between car pile was four feet.

These data are from a paper by G. T. Harley, efficiency engineer, Phelps-Dodge Corporation, published in *Engineering and Mining Journal* of Mar. 15 and 23, 1919.

## Wood Core Is Inside Form for Monolithic Concrete Conduit

CONDITIONS at the Gibraltar dam, near Santa Barbara, Calif., made it desirable that the concrete intake conduit should run from the intake tower upstream, beneath the shoulder of a projecting rock bluff, and through a tunnel to a point below the dam. In building the part under the overhang a bench was cut out of the rock, a wood core was placed for the inside form of the circular conduit, and straight outside forms were placed for the outside concrete wall, which was offset from the wall of the bluff.

The inside core form, of circular section resembling a wood-stave pipe, was made up of 1 x 3-in. strips nailed to circular segments and the reinforcement was attached to the core. Concrete was then poured in between the core and the outside forms. After the concrete had set the wooden core was broken up on the inside, and pieces were taken out at the intake tower end of the conduit. The contractors on the work were Bent Bros. and W. A. Kraner, the latter being in personal charge of construction.



AT LEFT, FORMS INSIDE OF CONDUIT; AT RIGHT, STRAIGHT WALL IS THE OUTSIDE OF CONDUIT

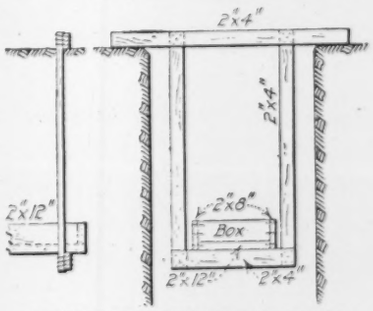
## Loose Bolts for Temporary Bridge Deck

DROP bolts which resemble loose drift bolts are used in constructing temporary bridge decks on the Alaska Ry. When material for the timber trusses is not available, the deck is laid, on the falsework bents on which the permanent structure is to be erected later on, and the fastening must be such that the deck can be taken down readily and without damage to the timbers. The bolts are ½ in. and ⅝ in. in diameter and 10 to 14 in. long, and the holes for them are bored to a diameter ⅛ in. larger, so that the bolts drop in easily. W. J. H. Fogelstrom is bridge engineer of the Alaskan Engineering Commission.

## Portable Trench-Excavation Platform Saves Shoveling Time

BY M. R. LEWIS
United States Reclamation Service, Boise, Idaho

FOUR men move the shoveling platform (illustrated by the accompanying drawing) in the time it takes to walk the distance of the move, or in about one-fifth the time taken to move the ordinary trenching platform. Platforms are always necessary in making deep trenches by hand. In trenching by machine they are frequently needed for cleaning up the bottom by hand.




HANGING SHOVELING PLATFORM EASILY MOVED BY FOUR MEN

Usually, such a platform is constructed by placing a shallow box or two or three planks on the trench braces, or on wood struts wedged across the trench. To move the platform when the trench is not sheeted requires 10 to 15 min., the time needed to take down both braces and replace them a few feet farther along the trench.

The platform illustrated sets in yokes hung from the trench edges. By using the projecting ends of the top pieces of the yokes, as handles, four men lift and move the whole assemblage in one operation.

This device was used by J. A. Hoskins & Co., contractors for the Malheur Drainage District at Ontario, Ore.

# NEWS OF THE WEEK

New York, April 17, 1919

## Railroad Administration Plans Use of Inland Waterways

In a letter to Senator Fletcher of the United States Senate Interstate Commerce Committee, Director General of Railroads Hines has announced the policy of the Railroad Administration in the matter of inland waterways. The nub of his statement is in the following paragraph: "The attitude of the Railroad Administration with respect to the relation between water and rail competitive rates is that the rates should bear a relation to each other proportionate to the cost and desirability of the service by the respective routes and methods of transportation."

He further states that the rate structure in the United States is so complicated and of such standing that the adjustment of one portion of it inevitably affects all the others, so that there seems to be little prospect of any reduction in the rate along the waterways. What can be hoped is that there will be an easier provision for transshipment by means of through waybills and through rates. There seems to be no prospect that the Railroad Administration will do anything to foster the traffic along the New York State Barge Canal, for Director General Hines says: "The administration has agreed, if the traffic justifies it, that it will establish joint rates between responsible independent canal lines and rail carriers under Federal control by connecting points on the canal."

In answer to one of Senator Fletcher's questions Director General Hines states that in the event of the railroads returning to private ownership, in his opinion it will be desirable to continue the Federal control of the waterways under some Government agency.

## New East River Tunnel In Service

Rapid-transit operation through the new pair of tunnels under the East River at New York City, extending from Old Slip, Manhattan Borough, to Clark St., Brooklyn Borough, was inaugurated on the morning of Apr. 15. The tunnels are part of the new west side subway, formed of that portion of the old subway extending north of Forty-second St. along Broadway, and the new Seventh Ave. subway extending south from Forty-second St. through Seventh Ave., Varick St. and West Broadway to South Ferry, and branching east along Park Place, Mail St., William St. and Old Slip to the tunnels. In Brooklyn the tunnels extend to Borough Hall and connect with the old subway. At that point trains of the east side and west side subway systems meet, the former reaching Brooklyn via the original Battery tunnels, whose easterly continuation is in Joralemon St., while the west side system uses the new Clark St. route. The present extension of the west side subway across the East River thus completes the separation of the old subway into the parts south and north of Forty-second St., and the joining of these parts with the new Lexington Ave. and Seventh Ave. subways to form independent east and west side systems.

Six rapid-transit tunnels under the East River remain to be opened to traffic: Two connecting Whitehall St., Manhattan, with Montague St., Brooklyn; two connecting Fourteenth St., Manhattan, with North Seventh St., Williamsburg; and two connecting Sixtieth St. with the Queensboro Plaza.

## Employment

For the convenience of engineers returning from military life, and others, there are listed below agencies which may be helpful to those who are seeking employment:

Engineering Societies Employment Bureau; secretary, 29 West 39th St., New York City.

American Association of Engineers, 29 So. La Salle St., Chicago. Service to members only, but Army or Navy engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, maintained by the Joint Council of Engineering Societies of San Francisco, Engineers' Club, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

*The Federal director of the United States Employment Service in New York State announces the receipt of a letter from J. P. Morgan & Co., in which $100,000 is offered for the purpose of continuing the work of the service up to July 1 of this year. The Professional and Special Section in New York will therefore be continued, but will be located at the main office, 469 Fifth Ave., New York City.*

## Federal Highway Council Formed

Pursuant to the intent of resolutions passed by the Highway Industries Association, following the Highway Congress held in Chicago last December, the Federal Highway Council was organized in Chicago, Apr. 8. The work of securing the coöperation of other organizations and their representation in the movement to promote a national highway system, and to create a Federal highway commission, has been going on for months under the auspices of a joint committee, headed by the Highway Industries Association; until now some 775 civic and commercial organizations throughout the country have indorsed the plan.

The meeting in Chicago decided that the work should be placed under the direction of a board of directors and the customary officers, supported and advised by an advisory committee composed of the leaders of the principal highway organizations.

Following the discussions which determined the type of organization, the Townsend bill, introduced in the last Congress and providing for the creation of a national highway system and a Federal highway commission, was considered and indorsed in all substantial features. A number of constructive suggestions were made, such as one fathered by A. R. Hirst, state highway engineer of Wisconsin, calling upon the Federal Highway Commission to maintain the existing road surfaces on all roads designated as parts of the national highway system as soon as they are taken over. These suggestions were passed along as matters for the consideration of the committee which drafted the bill.

The officers elected are as follows: Chairman, S. M. Williams; secretary-treasurer, H. G. Shirley; vice-chairmen, Coleman duPont, David Jamieson, Charles P. Clifton, Lewis J. Hill, A. H. Blanchard and C. F. Adams.

## Freight Reduced on Road Materials Consigned to Government

A reduction in freight rates on road-building material to be used on Federal, state, county, parish, township or municipal Government road work has been decided upon by Walker D. Hines, director general of railroads. This decision was reached after a consultation with the Departments of Agriculture, Commerce, and Labor. The reduction will not be allowed, however, unless the material is consigned to, and the freight thereon is paid by, the particular Government authority using

the material. The reduction will be 10c. per net ton, but a minimum charge of 40c. per net ton will be charged, except where the regular published rate is less than 40c. at the present time.

This ruling will authorize all railroads under Federal control to apply reduced rates on carload shipments of broken stone, slag, shells, chatts, cherts, sand and gravel, from May 1 to Dec. 31, 1919, where the material is to be used as outlined above. These reduced rates may be applied on shipments consigned to the Governmental unit but in care of a contractor, provided the freight is paid by the Government, and provided proper certification is made that the shipments are for the use of, and the reduction in rate will accrue to, the Government. Responsibility for administering this ruling rests with each railroad hauling such material.

## Money for Hudson River Tunnel Appropriated

On Apr. 11 Governor Smith of New York signed a bill making an appropriation of $1,000,000 for beginning construction of a vehicle tunnel under the Hudson River between New York and Jersey City. A New Jersey bill authorizing the construction of the tunnel has been signed by Governor Edge. The work will be in charge of the Interstate Bridge and Tunnel Commission, 115 Broadway, New York City.

## Designs Largest Concrete Arch

Minneapolis will have a concrete bridge with the longest reinforced-concrete span in the world, if the designs recently made by City Engineer F. W. Cappelen are adopted. This new bridge will be across the Mississippi River on the line of Franklin Ave., will have two end spans of 60 ft. each, two side spans of 200 ft. each, and a center span of 400 ft. The largest reinforced-concrete arch today is the Risorgimento Bridge across the Tiber at Rome, with a span of 100 m., or 328.1 ft. There was designed to cross Spuyten Duyvil in New York City some years ago a concrete arch, commonly known as the Hudson Memorial Bridge, with a clear span of 715 ft., but the project never got beyond the design stage. The Minneapolis City Council already has a fund of $50,000 from the sale of bonds for the construction of the bridge, and it is stated that work will begin as soon as possible.

## Pacific Coast Ship Contracts Reinstated

Reinstatement of canceled contracts for 25 steel vessels to be built for the Emergency Fleet Corporation by the Skinner & Eddy shipyard, Seattle, Wash., is reported. It is said that the price agreed upon is less than that fixed in the original contracts.

## Defense Council Reorganizes Highways Transport Committee

Reorganization of the Highways Transport Committee of the Council of National Defense is announced by Grosvenor V. Clarkson, director of the council. Direct representation for the Bureau of Public Roads and the Bureau of Markets of the Department of Agriculture, the Postoffice Department and the Department of Commerce is provided for. It is believed that closer coöperation of the departments most vitally interested in the matters of highway transportation, forming a clearing house of action for all Federal interests concerned, will thus be brought about.

Problems growing out of the entrance of the motor truck into the commercial transportation field will be one of the particular problems which the Transport Committee will take up. In carrying on this work, it will coöperate with all transportation agencies, including the United States Railroad Administration, in the study of the various problems of speedy and economical delivery of goods. Special attention will be given to the relation of the rural motor express to interurban electric lines and waterway traffic, in the interest of all elements concerned. While the regional directors of the Highway Transport Committee will still be retained, the committee itself has been reorganized, as follows:

John F. Cravens, of the Council of National Defense, chairman; James R. Blakslee, fourth assistant postmaster general; John M. Goodell, consulting engineer, Bureau of Public Roads; James H. Collins, investigator in market surveys, Bureau of Markets; R. S. MacElwee, second assistant chief of the Bureau of Foreign and Domestic Commerce; Charles W. Reid, executive secretary, and Grosvenor V. Clarkson, director of the council, member ex officio.

The committee will be assisted by the Highways Transport Committee Advisory Board, consisting of William Phelps Eno, of Washington, D. C.; A. H. Blanchard, of New York; C. A. Musselman, of Philadelphia; Raymond Beck, of Akron, Ohio, and John T. Stockton, of Chicago.

## Government Bureaus Do Not Agree on Steel Prices

Reduced prices for steel and iron, proposed by the Federal Industrial Board and agreed to by the steel producers, have been unsettled by the refusal of the Railroad Administration to approve them as being reasonable prices. Director General Hines has stated that he does not consider that there was any power conferred on the Industrial Board to impose any prices upon the Railroad Administration, and that the representative of the Railroad Administration who was in attendance in the conference which fixed the prices at no time approved of the decision. On behalf of the Industrial Board, Chairman G. N. Peek in a public statement defends the price established by the board and complains that Director General Hines is unreasonable in stating that in his opinion the prices are too high. Mr. Peek says the situation has become so involved it must be settled by the President.

## Conference on City Planning in Buffalo May 26-28

The eleventh annual national Conference on City Planning will be held May 26-28 at Niagara Falls and Buffalo, under the auspices of the American and Canadian cities and towns of the Niagara frontier.

The conference will meet two days at Niagara Falls and will then consider city-planning problems of growing industrial districts. There will also be discussed the problem of regional planning and the regulation of railroads as affecting civic development. On the third day of the meeting in Buffalo, residental zoning and civic centers will be discussed.

Flavel Shurtleff, 19 Congress St., Boston, is secretary of the conference.

## Better Pay for Oklahoma Engineers

Authority for salaries of $4200 per year for the county engineers of Tulsa and Oklahoma Counties was one result of an endeavor of the Oklahoma Society of Engineers to persuade the legislature to increase the pay of county highway engineers in general. It was proposed to change the pay from $5 per day, which the present law grants for time allowed by the county commissioners, to a sliding scale of salaries based upon county valuation. A bill was drawn originally to apply to Tulsa County only, but it was shown that some counties, in order to keep their engineers, were paying them (for extra services) $720 per year in addition to the $5 per day allowed by law.

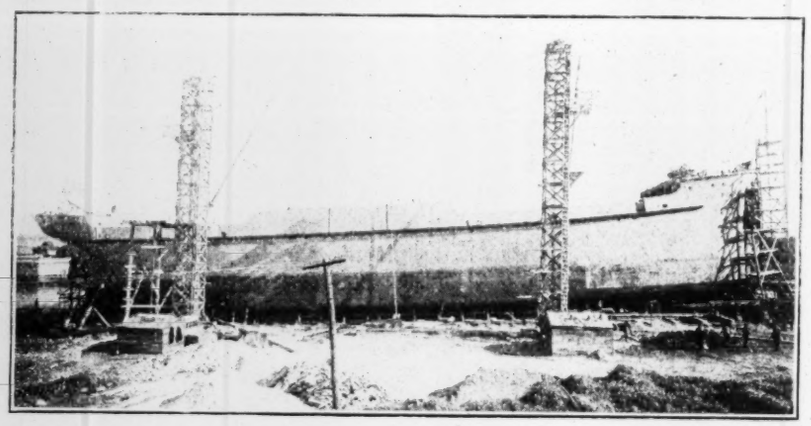
The amendment as proposed by the society was to legalize present salaries and to provide future salaries of $1800 for counties having less than $10,000,000 valuation, $2100 up to $20,000,000, $2400 up to $30,000,000, $2700 up to $40,000,000, $3000 for over $40,000,000; and not exceeding $4200 for counties having over $50,000,000 valuation. It provided also for inspectors on bridge and road work.

## Ford "Eagle" Built in Ten Days

On Apr. 12 the shipbuilding plant of the Ford Motor Co., at River Rogue, near Detroit, launched its "Eagle" boat No. 59 in 10 days after the keel was laid. This represents an outdoing of the 21-day operating schedule for which the plant was designed (see *Engineering News-Record* of Oct. 17 and 31, 1918, pp. 698 and 788) as the ship-assembly shop contains 21 building stations and the program was to launch a boat a day at the period of full production. The first "Eagle" was launched in July, 1918.

## Third American Concrete Ship Ready to Launch

Some time toward the end of April the United States Shipping Board concrete ship "Polias," which is shown practically completed in the accompanying view, will be launched at the yard of the Fougner Shipbuilding Co., on Long Island. This ship was described in detail in *Engineering News-Record* of Dec. 12, 1918, p. 1058. It



3500-TON CONCRETE SHIP READY TO LAUNCH AT FLUSHING, L. I.

is a 3500-ton vessel and is the third oceangoing concrete ship to be launched in this country. The "Faith," which was launched about a year ago, has successfully completed nearly 20,000 miles of ocean travel. The "Atlantus," the 3000-ton vessel which was launched at Brunswick, Ga., in December, 1918, is now being outfitted and should be ready for service in a short time. The "Polias" has been ready for launching for some time, but on account of difficulties in dredging the offshore slip, it has been held on the ways.

## Preliminary Report on Portland Elevator Subsidence

The committee of engineers appointed by the Portland Commission of Public Docks to report on the subsidence of the concrete municipal grain elevator being built at Portland, Ore., has presented a preliminary majority and minority report. The majority report, signed by Chairman H. C. Holmes, G. C. Mason, R. A. Cummings and G. W. Boschke, states that the storage annex should be supported by a spread foundation, and that this work can go on while the contractor is completing the structure. It is their opinion, furthermore, that the track shed can be left alone without any treatment whatsoever, the subsidence being very slight. The main report relates to the operating house, the part of the structure which has sunk the most. The report says there are two solutions which could be considered: First, to wreck the present structure and move the site of the operating house to a point south of the track shed, where it would be built upon a spread foundation; second, to complete the present operating house and to carry concrete cylinders under it to gravel.

The minority report, signed by W. R. Phillips, states that in the opinion of the signer the ground surrounding the storage annex is not sufficiently stable to carry the load of the annex upon a spread foundation. Nor does Mr. Phillips think that the proposed new site for the operating house would be stable. It is his opinion that the subsidence is still continuous. He therefore recommends that concrete cylinders be sunk to the underlying gravel under all of the buildings. This would require 63 cylinders for the storage annex alone.

No action has been announced as yet. The board of engineers is soon to present a final report.

## New State Commissioner of Highways Appointed in New York

Confirmation by the New York State Senate makes effective the appointment by Governor Smith of Capt. Frederick Stuart Greene as state commissioner of highways. He succeeds Edwin Duffey, who was appointed by Governor Whitman. There has been considerable controversy as to whether Mr. Duffey's term has expired. When he was appointed originally, the term of John N. Carlisle, then commissioner, had not yet expired. The term would have expired Apr. 29, 1918.

At the expiration time Commissioner Duffey was not reappointed, but merely held over. Attorney General Newton offered the opinion that his term expired on the aforesaid date, and as there had been no new appointment the present Governor was at liberty to make one.

Captain Greene is a resident of Nassau County and has had extensive experience in engineering and general construction work. Since 1905 he has been vice-president and general manager of the Waterproofing Co. of New York.

During the war he was a captain in the 302d Engineers and served in France.

## Idaho State Government Reorganized

Centralization of executive power and responsibility in the Governor of Idaho is effected by a bill which recently became a law. With the exception of the elective officials provided for by the Constitution and the officials of the Department of Education, all the various commissions, bureaus, etc., of the administrative branch of the Government of Idaho are done away with by the bill. In their place there are set up the following nine departments: Agriculture; commerce and industry; finance; immigration, labor and statistics; law enforcement; public investments; public welfare; public works; reclamation. A single commissioner will head each department. For some of the departments other officers are provided for by the statute. All of the officers named in the act are to be appointed by the Governor and may be removed at his discretion. The salary of each commissioner will be $3600 a year. Several departments will deal with engineering matters: The department of law enforcement will register architects, surveyors and civil engineers. The department of public works will take over the work previously done by the state highway department, by the trustees of the capitol building, and by the Heyburn Park board of control. The department of reclamation will take over the duties of the State Engineer and of the state board of land commissioners, except as to the duties of the latter in holding, leasing and selling state lands. The act provides that the director of highways in the department of public works must be a civil engineer of not less than five years' experience in road building, and that the director of water resources in the department of reclamation must be a hydraulic engineer with not less than five years' experience in the practice of irrigation engineering.

## Patent Office Employees Organize Society

For the purpose of advocating certain reforms in the administrative branches of the United States Patent Office, the employees have been organized under the name of the Patent Office Society which, it is claimed, will bring about a higher efficiency in the system. Committees on legislation and publicity have been appointed with a view to educating the public to the necessity for an immediate improvement of the present Patent Office system and to push Congressional enactment to broaden the scope of the office.

The plan includes the separation of the Patent Office from the Department of the Interior and provides for an executive officer who shall be an industrial and efficiency expert, the position eventually to be that of a cabinet officer when the department shall have assumed the proportions to warrant such a distinction.

The society proposes the establishment of five bureaus—namely, a bureau of information and education, a bureau of patents and publications, a bureau of utility, a bureau of validity examinations, and a bureau of priority of inventions.

The society is publishing a monthly journal in the interest of the principles being advocated in the reorganization of the Patent Office. The officers are as follows: President, M. H. Coulston; vice-president, J. H. Lightfoot; secretary, Bert Russell; treasurer, W. F. Avery.

## Low Price Asked for Building Fabricated Ships

An offer to build 12,000-ton steel vessels for the price of $149 per ton deadweight capacity has been made to the Shipping Board by the Submarine Boat Corporation, Newark, N. J. These vessels would be powered for 12 knots speed, with either reciprocating engines or geared turbines. The vessels would be 473 ft. long and 62 ft. in beam, and draw 28½ ft. The Newark Bay yard is at present building 5000-ton ships for the Fleet Corporation, using bridge-shop fabrication. Enlargement of the ways would be necessary to permit building the larger ships. It is proposed to reconstruct eight ways, and the price made is contingent on the ordering of 16 vessels. According to E. N. Hurley, chairman of the Shipping Board, steel ship prices in 1916 ranged from $50 to $69, while recent prices have been $185 to $225 per dead-weight ton.

## Members of National Societies Have Association in Cuba

What may prove to be a forerunner of similar association in this country is seen in the Association of Members of American National Engineering Societies in Cuba, recently organized to provide for activities "to foster the interests of the various national engineering societies represented on the island" and to promote the discussion of engineering and technical topics of local interest. Not the least attractive of the proposed activities are the dinners or smokers for the promotion of good-fellowship and for showing hospitality to members of the American societies temporarily visiting in Cuba. Luther Wagoner, president, suggests that since there is no danger of prohibition in Cuba there may be many visitors after July 1, who will be welcome.

## Filters Added and Water Softening Proposed at Minneapolis

Having enlarged its mechanical filtration to 24 units, with a total capacity of 96,000,000 gal., Minneapolis is now considering plans for water softening. The plant was put in operation in 1913. A previous enlargement was completed in 1917. W. N. Jones is in charge of filter design and construction and F. W. Cappellen is city engineer.

## Connecticut Electric Railways Bankrupt

Of the 828 miles of electric railways in Connecticut, 98% are either in the hands of a receiver or are insolvent, according to the report of a special commission made to the legislature Apr. 1. So bad is the situation that operations on many of these lines must be partially or completely suspended unless substantial temporary relief is afforded by the present legislature. The commission enumerates twelve causes that have contributed to create the financial difficulties. Besides the decrease in the value of the nickel railway fare and the great increase in cost of fuel, supplies and wages, the commission points out that a large part of the traffic formerly enjoyed by the electric railways is now carried by privately owned automobiles and by the unregulated jitney omnibuses. As a means of meeting this critical situation and enabling the companies to continue in operation, which is a public necessity, the commission recommends the release of the companies from the payment of state taxes and assessments for bridges and street paving. Motor omnibuses should be under state control so far as schedules, routes and rates are concerned, and should be compelled to give bonds for damages to injured persons. The electric railway companies should be permitted to abandon portions of their system which are unprofitable and to operate motor-vehicle service where desired. Bills have been drawn to carry out these recommendations and also providing for a loan of state funds, amounting to not more than $2,000,000, to electric railway companies to tide them over the present critical situation.

## City To Buy Dredged Fill from Government

New land is to be made by the City of Jersey City, N. J., on the Hackensack River, from fill which is to be dredged from the river by the United States Government. The city commissioners have just passed a resolution authorizing the city to purchase from the Federal Government enough of the dredged fill to make about 50 acres of new land 5 ft. above the present river level. The agreed price is 10c. per cubic yard, and the estimate provides for the removal of about 400,000 cu.yd. of material.

## New Assistant to Secretary of Interior Appointed

John W. Hallowell, member of the firm of Stone & Webster of Boston, who has been in close touch with engineering matters for the past 18 years, has been appointed the new assistant to the Secretary of the Interior, and will have under his immediate charge the Bureau of Mines, the Reclamation Service and the Alaska Ry. Mr. Hallowell has been associated with Stone & Webster for 16 years, specializing in the financial side of public utilities and other engineering projects.

Two years ago he joined the staff of the Food Administration, from which he resigned recently after his return from abroad, his last work being a survey of the industrial situation in Belgium and northern France. He succeeds H. A. Meyer, who resigned to become associated with the Prairie Oil & Gas Company.

## Industrial Conference Addressed by Prominent Men

At an editorial conference held under the auspices of the New York Business Publishers' Association in New York City on Apr. 11 some of the most prominent men in the country discussed the pressing industrial problems now before the country. Dr. Charles P. Steinmetz, consulting engineer of the General Electric Co., made a keen analysis of the various proposals for industrial coöperation. Dr. Charles A. Eaton presented a forceful address on the subject of industrial democracy, and John Calder, consulting engineer, formerly general manager of the Remington Typewriter Co., treated the subject of "Recent Advances in Industrial Management."

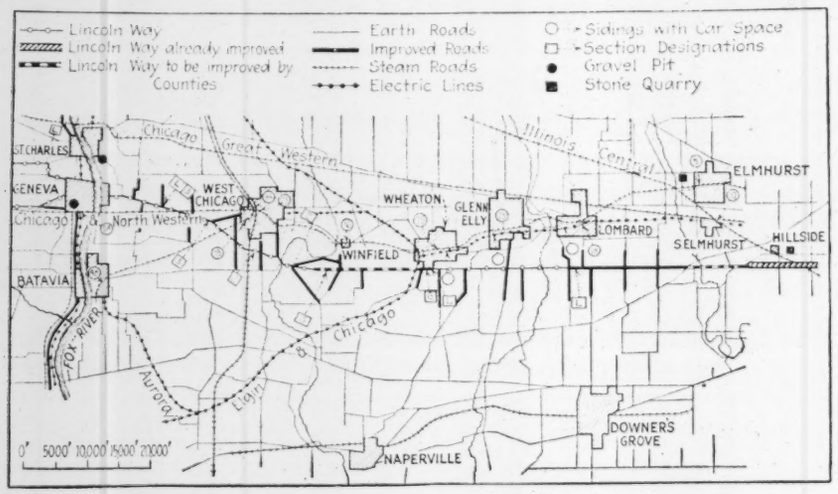
The necessity for organization in the settlement of labor disputes was the subject of an address by V. Everit Macy, chairman of a committee on adjusting wages in private shipbuilding plants during the war, and now president of the National Civic Federation. Four papers were presented on the subject of financial problems: "Post-War Financial Problems," by Francis H. Sisson, vice-president of the Guaranty Trust Co., New York; "Problems of Our Foreign Trade," by G. A. O'Reilly, foreign trade expert of the Irving National Bank, New York; "Prices Yesterday, Today and Tomorrow," by O. P. Austin, chief statistician of the National City Bank of New York, and "Stabilizing the Dollar in Purchasing Power," by Prof. Irving Fisher of Yale University.

## Surveys for Large Washington Irrigation Project

An appropriation of $100,000 for surveys of the Columbia irrigation project, embracing some 2,000,000 acres to be put under water in Washington, has been made by the state legislature. Water would be taken from Pend Oreille River at Albany Falls, just over the line in Idaho. Federal coöperation through the United States Reclamation Service is hoped for. The studies are being made under the direction of the Columbia Basin Commission, the chairman of which is Marvin Chace, state hydraulic engineer. It is reported that A. J. Turner, Seattle, has been appointed chief engineer, and J. C. Ralston, Spokane, consulting engineer to the commission, and that headquarters will be in Spokane.

## Pits and Quarries Mapped for Bidders on Road Work

Transportation routes and deposits of materials are mapped for the benefit of contractors who will submit bids and obtain contracts for 115 miles of the Dixie and Lincoln Highways to be built in Illinois in 1919. The fragment of the Lincoln Highway map reproduced here indicates the nature of the information depicted. Accompanying the maps are lists giving the car capacity of each railroad siding, and the character of the materials from each quarry and pit, together with the names of the operators. On the Lincoln Highway work, for example, 40 sidings are listed at 31 towns and cities, and on the Dixie Highway 31 sidings at 27 locations. For both contracts some 60 pits and quarries are listed. Clifford Older is chief state highway engineer.




MATERIAL DEPOSITS AND TRANSPORTATION FACILITIES MAPPED FOR ILLINOIS ROAD CONTRACTORS

## Funds Available For Extensive Road Work in Oregon

A total of about $30,000,000 is to be available for highway construction in Oregon during the next three years. Plans have been made for beginning immediately an extensive construction program. All of the work except the forestry roads will be under the direction of the State Highway Commission. Herbert Nunn is chief engineer.

The funds included in the total figure mentioned come from several sources. Before the legislature met this year there was a total of $3,500,000 in unexpended bonds remaining from the bonds authorized in 1917, and authority was given by the legislature to sell bonds for $10,000,000 more. The 1-mill tax is expected to net the road fund about $250,000 this year, while the tax on gasoline and distillate (1c. per gallon on the former and ½c. per gallon on the latter) will add $400,000. The net share from the auto-license department will be about $450,000 more. Federal funds for post and forestry roads to be used under the coöperative plan will also be forthcoming.

There are to be two road-bond issues on the ballot at the election in June, one for a property tax of one mill per annum for paying half the cost of local roads in those counties which will raise an equal amount, and also a measure providing for a military highway to be built along the full length of the Oregon coast, with $2,500,000 of state funds matched by an equal amount from Federal funds. The last project is the only one concerning which there is any doubt.

The plan for the expenditure of these funds calls for the completion of some 4000 miles of state highways. Of these, about 790 miles are to be hard-surfaced. On the coast roads concrete is specified wherever paving is to be done. On other parts of the system the type of road will depend on the prices bid, the alternative being bituminous pavement on macadam base. The concrete will be 6 to 7 in. thick, the 6-in. section being used in the dryer eastern part of the state, while the 7-in. depth is considered necessary west of the mountains. The pavements are to be laid 12, 16 and 18 ft. in width, depending upon the amount of travel; 80% will be 16 ft.; 15% 12 ft. and 5% 18 ft. wide., all with 2-ft. crushed-rock shoulders.

## Michigan Votes for Highway Bond Issue of $50,000,000

Aproval by the voters of Michigan of a highway bond issue of $50,000,000, assures the construction of the 5000-mile system of intercounty roads described in *Engineering News-Record* of Feb. 20, 1919, p. 399. The system is planned to reach every county in the state.

While the road-bond issue voted on Apr. 7 was carried by a large majority, it is significant that the constitutional amendment which would have provided for the sale and manufacture of beer and wine was rejected. It will be remembered that the brewing interests tried to tie these two propositions together during the campaign.

## Kansas Plans State-Aid for Roads

State aid for highway construction in Kansas is provided for by a constitutional amendment passed at the recent session of the state legislature, and this will be submitted to public vote at the general election in 1920. If it is carried it will permit the state to pay 25% of the cost of road construction, not to exceed $10,000 per mile and not to exceed 100 miles in any one county, except that this may be 150 miles for counties having an assessed valuation of over $100,000,000. The amendment provides also that the state may reimburse the counties which build roads after March, 1919, if the legislature so desires. It is pointed out that this constitutional amendment is more of a legislative act than a part of a constitution, but it was all that could be obtained from the recent session of the legislature.

The outlook for road work in Kansas during the coming season is said to be good. The Federal-aid funds will be taken care of with an equal amount from the counties. It is estimated that this, with a considerable amount of other work, will involve about $8,000,000 per year for the next two years. High prices are delaying progress, but with 50% aid it is hoped to get a good percentage of the work under way at an early date. Contracts have been let for five sections of road, and other contracts will soon be ready for letting. The State Highway Commission, however, has received so small an appropriation that it will have some difficulty in handling the work. M. W. Watson is acting state highway engineer.

## Iowa Has Extensive Road Program

Hard surfacing of the intercounty road system, which consists of approximately 6000 miles of the most important roads in the state, during a period of 10 to 12 years, is provided for in a bill now before the Iowa legislature. Provision for bond issues in limited quantities by the counties is included, but bonding is not advocated or recommended, except in a few counties where the work should progress more rapidly. The bill covers the establishment of a primary road fund composed of the automobile fees and the Federal-aid money received each year. This fund is to pay 75 per cent. of the expense and the remainder is to be assessed against the adjacent property, for 1½ miles back on each side of the road.

Under the first Federal-aid law Iowa has 27 projects estimated to cost $105,630. These total 394 miles, principally of grading and draining. It is expected that they will be put under contract soon, and that work will be started early in the summer. Bids on two or three of these have been rejected as being too high. There are also projects aggregating $1,000,000, in progress in 13 other counties, for which contracts may be let and work started this year.

### Civil Service Examinations

**New York.**—Junior assistant engineer, State Engineer and Highway Department, $1200-$1440 per year, May 24. Apply to State Civil Service Commission, Albany, N. Y. File applications before May 24.

**New York.**—Bridge designer, Public Service Commission, First District, $1501 to $2100 per year. Apply to State Civil Service Commission, Albany, N. Y. File applications before May 24.

For United States Civil Service examinations listed below, apply to United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

**United States.**—Engineer-draftsman, Apr. 22, $1500 to $1800 per year. File Application before Apr. 22.

**United States.**—Transitman, $100 to $125 per month, and surveyor, $125 to $200 per month, Apr. 23-24. File applications in time to arrange for examination at place selected by applicant.

**United States.**—Expert patent investigator, $1800 to $2400 per year, and technical patent expert, $2400 to $3600 per year, May 20.

**United States.**—Highway bridge engineer, $1800 to $2100 per year, junior highway bridge engineer, $1200 to $1600 per year, Bureau of Public Roads and Rural Engineering, May 21. File applications in time to arrange for examination at place selected by applicant.

**United States.**—Engineer in forest products, $1860-$3000 per year; assistant engineer in forest products, $1200-$1800 per year, Forest Products Laboratory, Madison, Wis., May 27. File applications before May 27.

**United States.**—Chief of road survey party, $1800 to $2100 per year, transitman for road surveys, $1200 to $1800 per year, highway draftsman, $1200 to $1800 per year, Bureau of Public Roads and Rural Engineering, May 29. File applications before May 29.

**United States.**—Scientific assistant in public health work, Public Health Service, $1500-$2500 per year, June 3. Apply for form 2118, to be filed before June 3.

**United States.**—Senior engineer and senior architect, Interstate Commerce Commission, $1800-$2700 per year, June 10. File applications before June 10.

**United States.**—Assistant material engineer, Bureau of Construction and Repair, from $4.48 to $6.40 and upwards per diem. No date specified. Applications should be filed without delay.

**United States.**—Junior recreational engineer, Forest Service, Denver, Colo., $1800 to $2400 per year, May 6. Apply for Form 2118.

**United States.**—Statistician, Department of Interior, $1800 per year, May 13. Apply for Form 2118.

## ENGINEERING SOCIETIES

### Calendar

**Annual Meetings**

NATIONAL FIRE PROTECTION ASSOCIATION; 87 Milk St., Boston, Mass.; May 6-8, Ottawa, Can.

AMERICAN ASSOCIATION OF ENGINEERS, 29 S. LaSalle St., Chicago; May 13-14, Chicago.

NATIONAL CONFERENCE ON CITY PLANNING; 19 Congress St., Boston; May 26-28, Niagara Falls and Buffalo.

AMERICAN WATER-WORKS ASSOCIATION; 47 State St., Troy, N. Y.; June 9-13, Buffalo, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS; 29 W. 39th St., New York; June 17-20, St. Paul-Minneapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS; University of Pennsylvania, Philadelphia; June 24-27, Atlantic City, N. J.

AMERICAN CONCRETE INSTITUTE; 6 Beacon St., Boston; June 27-28, Atlantic City, N. J.

**The Rochester (N. Y.) Engineering Society** will hold a meeting Apr. 25 in conjunction with the regular monthly meeting of the local section of the American Institute of Electrical Engineers. The speaker will be Prof. Vladimir Karapetoff, of Cornell University.

**The Engineers' Club of Philadelphia** will be addressed by Prof. George B. Pegram, dean of the School of Mines, Engineering and Chemistry, Columbia University, on "A Broader Type of Training for Engineers," at the weekly luncheon Apr. 22.

**The Engineers' Society of Milwaukee** held a joint meeting with the Milwaukee sections of the national engineering societies Apr. 16, at which George R. Lawrence, president of the Lewis-Lawrence Aëroplane Co., Chicago, presented an illustrated paper on "Flying Today and Tomorrow."

**The Engineers' Club of Trenton, N. J.,** was addressed Apr. 10 by H. C. Eddy, senior inspector of traffic, Public Utility Commission of New Jersey, who spoke on "The Development of the Electric Railway."

**The Brooklyn Engineers' Club** will be addressed at the meeting Apr. 17 by Maj. W. McI. Wolfe, who will speak on "The Work of Engineer Troops in France." At the Apr. 24 meeting, to be held in the Sperry Building, Manhattan Bridge Plaza, Brooklyn, Elmer A. Sperry, of the Sperry Gyroscope Co., will speak on "The Sperry Searchlight" and will give a demonstration of the searchlight on the roof of the building, if weather permits.

**The Engineers' Society of Northeastern Pennsylvania** will hold its regular monthly meeting at Scranton, Apr. 17. Maj. L. S. Doten will speak on "Sewage Disposal in Army Camps."

**The Engineers' Club of Cincinnati** will be addressed Apr. 17, by W. W. Freeman, president of the Union Gas & Electric Co., on "Power Problems of a Modern City and Their Solution."

## PERSONAL NOTES

G. A. TOMLINSON, director of inland waterways and canals, United States Railroad Administration, has resigned and will soon go to London to become resident director there of the American Shipbuilding Co., which controls a number of shipyards on the Great Lakes.

J. R. WEST, for the past three years professor of railway and structural engineering, Pei Yang University, Tientsin, China, has been appointed engineer-in-chief of the Min River Conservancy at Foochow, China, for the purpose of regulating and deepening the Min River to permit steamers engaged in coastwise trade to reach the wharves at Foochow.

LEROY D. GIFFORD, formerly construction engineer, California State Highway Commission, and recently of the 19th Regiment C. A. C., has returned to civil life and is engaged in establishing a chemical manufacturing plant at Anaheim, Calif., to specialize in citrous byproducts.

CAPT. L. R. MACKENZIE, U. S. A., recently engineer of roads on the staff of the commanding general, port of embarkation, Newport News, Va., has been appointed district engineer in charge of the new district office of the Portland Cement Association at Des Moines, Ia.

EDWIN R. WEBSTER, for several years assistant engineer on the Iowa and Dakota divisions of the Chicago, Milwaukee & St. Paul R.R., in charge of construction and maintenance work, has taken up private practice in general civil and sanitary engineering and has opened an office at 327 S. La Salle St., Chicago.

CHARLES H. HURD, consulting engineer, Indianapolis, whose resignation from the Board of Sanitary Commissioners was noted in *Engineering News-Record* of Apr. 3, 1919, p. 693, has been apponted supervising engineer of construction for the commis-

sion. He will have charge of the building of the new city sewage-disposal plant. Mr. Hurd went to Indianapolis as chief engineer of the Indianapolis Water Co., later becoming its vice-president.

CAPT. ERLE P. DUDLEY, Engineers, U. S. A., who recently returned from overseas, has received his discharge from the service and has resumed his work with the Bunker Hill & Sullivan Mining & Concentrating Co., Kellogg, Idaho.

ROBERT GARDNER, assistant superintendent of the water department, Lowell, Mass., has been appointed superintendent of the department, succeeding Robert J. Thomas, who has resigned to become New England representative of the Gamon Meter Co., Newark, N. J., as noted elsewhere.

MAJ. ROBERT A. ALLTON, Field Artillery, U. S. A., who has received his discharge from the Army, has resumed his position with Samuel A. Greeley, hydraulic and sanitary engineer, Chicago.

CHARLES B. BALL, chief sanitary inspector for the Department of Health, Chicago, has been granted leave of absence to go to France as an adviser in the work which the Y. M. C. A. is undertaking for housing and city planning in the devasted districts.

H. E. PHELPS, assistant sanitary engineer, United States Public Health Service at Petersburg, Va., has resigned to become highway engineer for Moreland and Bennett Counties, at Pine Bluff, Ark.

LIEUT. RAYMOND G. CLINITE, Corps of Engineers, U. S. A., who recently received his discharge from the service, has resumed his work as assistant topographer, United States Geological Survey.

CAPT. WILLIAM T. HUBER, Engineers, U. S. A., who was recently discharged from the service, has become field engineer for the Portland Cement Association, in charge of western New York territory.

BURT A. HEINLY, formerly associated with William Mulholland, chief engineer for the Department of Public Service, Los Angeles, has entered the employ of the California Willite Road Construction Co., Los Angeles.

CAPT. C. A. JENNINGS, Construction Division, U. S. A., has received his discharge from the service and has returned to the technical staff of the Wallace & Tiernan Co., New York City, to resume charge of the Chicago office. While in the Army his work was done in the supervision, operation and maintenance of water-purification and sewage-treatment plants in various camps.

JOHN T. GEPHART, JR., for the past three years county engineer of Fayette County, at Uniontown, Penn., has resigned to enter a state position at Harrisburg.

ENSIGN EDMUND A. PRENTIS, JR., U. S. N. R. F., has been placed on inactive duty by the Navy Department and has resumed his connection with the Underpinning & Foundation Co., New York City.

CAPT. HARRY C. KITTREDGE, Engineers, U. S. A., who recently received his discharge from the service, has been appointed superintendent of city construction, Rochester, N. Y.

D. C. FENSTERMAKER has been appointed district engingeer, Chicago, Milwaukee & St. Paul R.R., with headquarters in Chicago.

A. C. BLAIR, Lyons, Kan., has been appointed to the State Highway Commission, succeeding E. R. Moses, resigned.

E. C. MCCULLOUGH, assistant road engineer of Fayette County, Uniontown, Penn., has been appointed connty engineer, succeeding John T. Gephart, Jr., as noted above.

CAPT. JOHN A. MCLEAN has been appointed city engineer of Crookston, Minn., succeeding A. Hunt, who resigned on account of poor health.

W. S. LOZIER, chief project engineer, United States Shipping Board, Housing Department, Philadelphia, has returned to Rochester, N. Y., to resume private practice.

CAPT. CHARLES L. COULSON, 2nd Canadian Division, at present in England awaiting demobilization, has been appointed city engineer of Welland, Ont. The City Council will endeavor to obtain his release from military service as soon as possible.

ROBERT J. THOMAS, for thirty years superintendent of the waterworks department of Lowell, Mass., has been appointed New England representative of the Gamon Meter Co., Newark, N. J. He is succeeded by Robert Gardner, as noted elsewhere.

JOHN R. ALLEN, dean of the College of Engineering and Architecture, University of Minnesota, has been appointed director of a national bureau for heating and ventilation research. His work will be done in connection with the research laboratory maintained by the United States Bureau of Mines in Pittsburgh. Although the formal contract has not yet been announced, it is understood that he will select his staff, which is expected to begin work in August. Dean Allen went to the University of Minnesota from the University of Michigan in 1917.

SAMUEL A. GREELEY, hydraulic and sanitary engineer, announces that he has moved to new offices at 39 W. Adams St., Chicago.

## OBITUARY

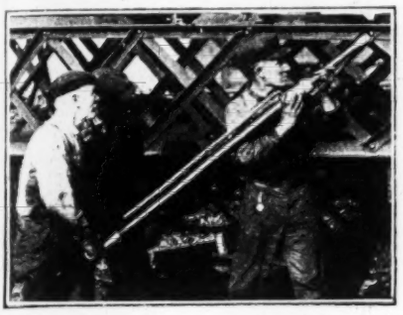
CURTIS DOUGHERTY, chief engineer, maintenance of way and structures, Southern Railway System, West, died in Cincinnati Mar. 30. He was born in 1863 and was graduated from Washington University, St. Louis, in 1886 with the degree of C. E., shortly afterward entering the chief engineer's office of the Wisconsin Central Ry. From 1888 to 1892 he was assistant engineer, Chicago & Western Indiana R.R. at Chicago, and for the following nine years was roadmaster of the Chicago division of the Illinois Central R.R. He afterward became superintendent of the Springfield division of the Illinois Central at Clinton, Ill., and in 1907 was appointed assistant chief engineer, Cincinnati, New Orleans & Texas Pacific Ry.-Alabama Great Northern R.R. From 1910 to 1917 he served as chief engineer of the two railroads. In 1917 he was appointed chief engineer, maintenance of way and structures, Southern Railway System, Lines West.

MARSHALL TEN BROECK DAVIDSON, president of the M. T. Davidson Co., pump manufacturers, died in Brooklyn, N. Y., Apr. 10. He was born in 1837 and was educated in the public schools and the Academy at Hudson, N. Y. In 1857 he entered a marine-engine machine shop in New York City and later went to sea as assistant engineer. He served as a chief engineer in Army transport service during the Civil War. After the war he engaged in business as a contracting mechanical engineer and in 1878 commenced the building of the Davidson steam pump and pumping engine. He constructed the pumping machinery for the old City of Brooklyn and the high-service pumping engine at the Prospect Park reservoir, as well as the machinery for the water-works extension at the Millburn station.

CHARLES E. WESTLAND, who became assistant to the hydraulic engineer, Turners Falls Power & Electric Co., after his release from the Reserve Officers' Artillery Training School at Fortress Monroe, died at Turners Falls Apr. 5. He was graduated recently from the Massachusetts Institute of Technology.

## Special Pneumatic Device for Cutting Rivet Heads

A pneumatic rivet cutter for use on structural steel work and in repair shops is shown in the accompanying view. It consists of a long barrel with compressed air connection at one end and a chisel at the other, the stem of the chisel being held by a coiled spring which draws it back after each stroke. A plunger travels freely in the



RIVET CUTTER IN USE ON STRUCTURAL WORK

barrel or tube, and a small bypass pipe connects the ends of this tube. Two men are employed, the one at the rear operating the valve and the one at the front keeping the chisel against the rivet head.

In operation, air is admitted first through the bypass pipe to the chisel end of the tube and drives back the plunger, the shock being absorbed by a coiled spring. Air is then admitted at the other end of the tube and drives the plunger forcibly against the stem of the chisel. Another turn of the valve exhausts the air charge and admits air again through the bypass to drive back the plunger for another stroke. The force of the blow can be regulated by the valve. Air pressure of 40 to 90 lb. may be used, the higher pressures being the more effective. A punch can be inserted in place of the chisel for backing out the rivets.

In the larger size the stroke is 40 in., and the weight of the machine complete is only 65 lb. A smaller size will cut rivets up to ⅝ in. in diameter. These two sizes are known respectively as the "Red Devil" and the "Baby Devil." They are made by the Rice Manufacturing Co., Indianapolis, Ind.

## Manufacturers of Electric-Furnace Products Organize

An organization to be known as the Electric Furnace Association was formed at a meeting called at Niagara Falls Mar. 21-22. Representatives of a large number of companies manufacturing electric-furnace equipment, accessories, etc., and electric-furnace products were present. The following officers were elected: President, Acheson Smith, of the Acheson Graphite Co., Niagara Falls; Secretary, C. G. Schluederberg, Westinghouse Electric Manufacturing Co., Pittsburgh.

## Building Materials and Machinery For South America

According to a recent report issued by the Department of Commerce, the time is ripe for the sale of construction materials and machinery in several South American countries. This is notably the case in Chile, Peru and Ecuador. The Chilean public is generally favorably impressed with American goods and considers them more up to date than those from Europe.

Large amounts of public improvements are contemplated in these countries, which are more prosperous than before the war, and, having become more progressive, they desire all manner of sanitary fixtures, etc. A publication entitled "Construction Materials and Machinery in Chile, Peru and Ecuador," covering this subject in detail, may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

# Business Notes

Charles F. Ames & Co., Ltd., 90 West St., New York City, announces that they have been appointed to act as the New York sales department of the Platt Iron Works of Dayton, Ohio, handling the pumping and power-plant equipment of the latter.

The Chicago Pneumatic Tool Co. has disposed of its Giant truck department and will confine its operations hereafter to its pneumatic-tool, electric-tool, air-compressor and oil-engine lines. The truck business, consisting of the Chicago Heights plant, with all stocks, inventories, agencies and branches, has been transferred, and the purchasers will continue the business, probably under the title of the Giant Truck Corporation. The tool company also announces that F. V. Sargent has been appointed district manager of sales for its Boston territory, succeeding F. S. Eggleston. The headquarters will be at 182 High St., Boston, Mass.

The Turner Construction Co. has opened an office in Philadelphia in the Presser Building, 1713 Sansom St. It will be a complete unit of the parent organization.

The Advance Machinery and Supply Co., of Denver, Colo., announces that Lieut. F. A. Koenig, recently discharged from the coast artillery service, has joined its organization as sales engineer.

The Trailer Manufacturers' Association of America, the reorganization of which was reported in *Engineering News-Record* of Mar. 6, 1919, p. 499, has announced the appointment of H. W. Perry as general manager. Mr. Perry has been associated with the National Automobile Chamber of Commerce for the past nine years, was secretary of the commercial-vehicle, good-roads, legislative, and export committees, and recently has been manager of the statistical and information department, with offices at Washington. The offices of the association will be located in New York City.

E. I. du Pont de Nemours & Co., Wilmington, Del., announce the following changes in the personnel of their organization: T. E. Doremus has been transferred to the export division of the company as general Eastern manager, with headquarters in Shanghai, China; E. R. Galvin has been appointed manager of the sporting powder division to succeed Mr. Doremus.

# Trade Publications

The Central Foundry Co., 90 West St., New York City, has issued a pamphlet containing instructions for laying Universal cast-iron pipe and connecting up the joints. There are 11 pages, 2¾ x 4½ in., with illustrations.

A set of five catalogs has been issued by the Chain Belt Co., of Milwaukee, Wis., covering the various sizes of Rex mixers. Of these catalog 95 is a general pamphlet covering all the sizes. Catalogs 101, 102, 103 and 104 contain descriptions with methods of using various types recommended for building and paving work. The catalogs are illustrated with line cuts and half tones and are 7½ x 10 in. in size.

The C. H. & E. Manufacturing Co., Inc., has issued bulletins Nos. 2 and 3. No. 2 covers power pumps, while No. 3 covers hoists, elevators, mortar mixers and engines.

The Edward F. Terry Manufacturing Co., Grand Central Terminal, New York City, has issued Bulletin No. 3, devoted to cargo cranes. This bulletin contains fifteen 8½ x 12-in. pp. and illustrations on the methods of loading ships by the use of traveling cranes.

"Concrete Chutes and Equipment" is the title of bulletin No. 200 recently issued by the Ransome Concrete Machinery Co., Dunellen, N. J. It covers a complete line of chutes and other auxiliary concreting equipment, is 8½ x 11 in. in size, contains 51 pages and is illustrated.

"Blueprint Suggestions on Haulage, Loading Stations and Mixer Equipment for Road Work" is the title of a book recently issued by the Koehring Machine Co., Milwaukee, Wis. The pamphlet is 9¾ by 5¾ in. and consists of 10 pp. of reading matter and nine charts, showing the layout for different kinds of machinery on road operations. These charts are in blueprint form and are folded in to fit the size of the booklet